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STRATEGY IN THE ROBOTIC AGE: A CASE FOR AUTONOMOUS WARFARE

by

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The advent of a Robotic Age in combat has set the stage for a renewed style of warfare: autonomous warfare. The outstanding feature of this new era is the arrival of robotics on the battlefield, but the significance of the new warfare style is that it mandates a shift in the way humans approach modern combat. In 2010, the Department of Defense restated autonomy as the "single greatest theme" for today's unmanned systems. Autonomy, however, has long been a theme in warfare and weapons; therefore, the concept should apply to both those who fight and to their machines. Autonomy is the current buzzword for improving technology, but increasing autonomy for the soldier or combatant is the defining characteristic of autonomous warfare. With a view to this development, this study suggests changes in the character of war, and proposes autonomous warfare as an operating concept that empowers, rather than replaces, humans in battle.

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STRATEGY IN THE ROBOTIC AGE: A CASE FOR AUTONOMOUS WARFARE

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ABSTRACT

The advent of a Robotic Age in combat has set the stage for a renewed style of warfare: autonomous warfare. The outstanding feature of this new era is the arrival of robotics on the battlefield, but the significance of the new warfare style is that it mandates a shift in the way humans approach modern combat. In 2010, the Department of Defense restated autonomy as the "single greatest theme" for today's unmanned systems. Autonomy, however, has long been a theme in warfare and weapons; therefore, the concept should apply to both those who fight and to their machines. Autonomy is the current buzzword for improving technology, but increasing autonomy for the soldier or combatant is the defining characteristic of autonomous warfare. With a view to this development, this study suggests changes in the character of war, and proposes autonomous warfare as an operating concept that empowers, rather than replaces, humans in battle.

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LIST OF ACRONYMS AND ABBREVIATIONS

AI	Artificial Intelligence
LARs	Lethal Autonomous Robots
LAWS	Lethal Autonomous Weapons Systems
TALOS	Tactical Assault Light Operator Suit
UAV	unmanned aerial vehicle
UGV	unmanned ground vehicle
ULV	unmanned landing vehicle
USSOCOM	U.S. Special Operations Command
USV	unmanned surface vessel
UUV	unmanned underwater vessel

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The Navy is often criticized, or at least questioned, for its commitment to higher education for naval officers. The Naval Postgraduate School is living proof that all is not lost. I am thankful to the U.S. Navy and to the Naval Postgraduate School for affording me the opportunity to renew my passion for learning.

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I. INTRODUCTION

Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur.

—General Giulio Douhet, 1921[1]

To assume that one method of conducting war will suit all kinds of war is to fall victim to abstract theory.

—Sir Julian Corbett, 1911[2]

If we are ignorant of the changing face of war, we will find ourselves unequal to its challenges.

—U.S. Marine Corps, 1997[3]

A. PURPOSE

The character of war stands at a crossroads in the second decade of the 21st century. The Robotic Age is arriving, and it is setting the stage for a renewed style of warfare: autonomous warfare. The obvious component in this new era is the arrival of robotics on the battlefield, but the significance of the new warfare style is about a nuance for the human mindset in modern combat. In 2010, the Department of Defense restated autonomy as the "single greatest theme" for advancing modern unmanned systems.[4] Autonomy, however, has always been a theme in warfare; therefore, the concept of autonomy should apply to both man and machine. Autonomy is the current buzzword for

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[1] Giulio Douhet, *The Command of the Air*, trans. Dino Ferrari (New York: Coward-McCann, 1942; reprinted Washington, DC: Office of Air Force History, 1983), 30.

[2] Julian S. Corbett, *Principles of Maritime Strategy* (London: Longmans, 1911; reprinted Mineola, NY: Dover, 2004), 25. Citations refer to the Dover edition.

[3] U.S. Marine Corps, *Marine Corps Doctrinal Publication 1 (MCDP-1): Warfighting* (Washington, DC: Department of the Navy, June 1997), 18, https://www.doctrine.usmc.mil/signpubs/mcdp1.pdf.

[4] Office of the Undersecretary of Defense (OUSD) for Acquisition, Technology, & Logistics (AT&L), "Unmanned Systems Integrated Roadmap, FY2011–2036" (Washington, DC: Government Printing Office, October 2011), 43, http://www.dtic.mil/docs/citations/ADA558615; the quote was restated from U.S. Air Force, "Technology Horizons: A Vision for Air Force Science & Technology 2010–2030" (Maxwell AFB, AL: Office of the U.S. Air Force Chief Scientist, May 2010), xx, http://www.defenseinnovationmarketplace.mil/resources/AF_TechnologyHorizons2010-2030.pdf.

improving technology, but increasing autonomy for the human warfighter is the defining characteristic of autonomous warfare. Arsenals and armies between man and machine are striking a new partnership. Autonomous warfare maintains combat power among people, and yet the quantity of machines in battle will grow too. The U.S. military is incorporating new robotics technology in an evolutionary fashion, which may be the right approach, but it might also be wrong. It is too early to tell. The implications of such change require a careful analysis. This study anticipates the coming changes in the character of war, proposes autonomous warfare as an operating concept that empowers, rather than replaces humans in battle, and evaluates the implications for strategy in the Robotic Age.

There are four parts to this work. Chapter I provides the overall context and definitions of terms. Chapter II evaluates the rise of armored fighting vehicles as a previous case of change in the character of war to examine the impacts on doctrine, strategy, and policy. Chapter III explores some of the military problems and opportunities that may well emerge during the Robotic Age, and evaluates several ways to employ autonomous warfare. Chapter IV summarizes this inquiry with an analysis on strategy in the Robotic Age.

B. BACKGROUND

A century ago, in 1914, the era of total war broke upon the world, and lasted for over three decades. A new form of industrial warfare had first emerged during the American Civil War fifty years prior, but the long-term ramifications, at the time unforeseen by most observers of armies and war, came into full force between 1914–1918. By the turn of the 20th century, machines had deeply changed the way people traveled, with planes in the air, cars, trucks, trains, and soon tanks on the ground, and powered vessels on and beneath the sea. Other kinds of machines from the second industrial revolution changed the way people communicated, with wireless radios, and offered a new way to perceive combat in the air and at sea, with the advent of radar. Machine-guns dramatically changed the rate of fire between enemies, altering first tactics and then strategy. Improvements in artillery and the means to coordinate mass firepower

on an unknown scale forced troops to disperse to avoid annihilation. These changes in the weapons and physical character of war altered the conceptual approach to fire and maneuver, an issue that initially stymied belligerents in World War I and led to unimaginable carnage.[5]

In his crucial analysis of the philosophy of war and its change from dynastic Europe to revolutionary Europe, Carl von Clausewitz wrote, "it is just as improbable that wars henceforth will all have this grand [absolute] character as that the wide barriers which have been opened to them will ever be completely closed again."[6] Such a generalization has been no less germane to the political and technological change of the epoch of total war. Emerging from the chaos of the first Great War, the victors and the defeated perceived the changes in warfare according to differing strategic legacies derived from historical experience, society and politics. Two decades later, the victors who failed to embrace the changes in the character of war a second time paid another deadly price. "The most ominous lesson of World War I," according to Bernard Brodie, "is that the vast advance in the technology of war which distinguishes the twentieth century from the nineteenth century has been attended by suppression of rational concern with the political aims of war."[7] In other words, baffling changes in the character of war in its many dimensions overwhelmed commanders and statesmen alike in their ability to develop strategy, that is to match force with policy, and the means and ends of war in some rational manner.

Fortunately, the Allies did eventually adapt their strategy and their weapons to the Axis assault, and by the end of World War II, the United States emerged as a global power. In the years shortly thereafter, American military power continued to build on the elements that achieved victory: atomic weapons, armored land armies, strategic bombers and strike aircraft carriers form prime examples. For the remainder of the 20th century, these wartime forces and weapons grew incrementally larger and delivered more firepower. At the same time, however, equipment costs have risen, inventories are

[5] Donald Abenheim, email message to the author, April 22, 2014.

[6] Bernard Brodie, *Strategy in the Missile Age* (Princeton, NJ: Princeton University Press, 1959), 68.

[7] Ibid., 67.

decreasing, and the risk of losing a ship or plane nearly prohibits its use. In a way similar to the strategic and technological confusion that arose from the break neck changes in warfare from the American Civil War to World War II, the world is again faced with an era of change in the character of modern war that threatens to upend America's current military strengths. It also would not be surprising if Americans, the greatest beneficiaries of the military-technical status quo, would be slow to recognize the pending transformation of warfare.

In the 21st century, the character of war is undergoing a period of change heralded by the 2001 assault and its aftermath, as well as the march of new weapons and new battlefields, and how men and women see them and think about them. Change in the character of war is a reflection of new ways that war is fought based on the technology and resources available of an era, and our era is the digital and robotic era. This fact is not to suggest that the *nature* of war is changing as a feature of the political and social cosmos, or as an ill of the human condition. It is widely agreed that war has been and will remain a violent act of force, subordinated to policy, determined by human will, and seized of the juncture of politics and mass psychology. Change in the *character* of war, however, is nonetheless important because victory is achieved by those states that foresee and adapt to change before an adversary introduces transformational technology in a strategic surprise.

The kind of change that the powers confronted in WWI and refined for WWII was fundamentally about the warfighting roles of fire and maneuver. For the latter, the change put aircraft and armored fighting vehicles at the apex of the hierarchy on the battlefield. Crews of soldiers, sailors, airmen, and marines were called to join in the bellies of steel beasts to mass combat power on the tactical and then operational levels. These internal combustion engine fighting machines represented a fundamental shift in warfare since the 15th century *lansquenets,* or "recruited private soldiers," transformed infantry from "simple individual warriors" to "definite tactical bodies … accustomed to finding their strength precisely in this closed formation," according to historian Hans Delbrueck.[8] He

[8] Hans Delbrueck, *The History of the Art of War, Volume IV: The Dawn of Modern Warfare,* trans. Walter J. Renfroe Jr. (Lincoln: University of Nebraska, 1985), 10.

also wrote, “The transition from the Middle Ages to the modern period was marked by the great increase in the means of waging war,” most notably, “the technology of the new firearms.”[9] As well as how states and nations organized their armies with the change in society and economy. From simple warriors to infantry squares to armored columns, the Robotic Age represents the latest major shift in warfare styles and formations.

C. DEFINITIONS

The following definitions may be used in other contexts, or may be assigned different meaning by different authors, but these definitions are offered here in the effort to better explore more novel concepts introduced throughout the course of the thesis.

1. Nature and Character of War

This study maintains a distinction between the nature of war versus the character of war. The nature of war refers to the aspects of war that are enduring across time and the change in weapons, states, and societies. War as a violent contest determined by human will and used to achieve national interests. Friction, uncertainty, chance, and fluidity are some of the other factors that are inherent to the nature of war. The character of war, on the other hand, changes over time based on the military, political, social, technological, and economic interests of the opposing states at the time. Clausewitz called these characteristics the “spirit of the age.”[10] The character of war relates to the conduct of war, or warfare–how a war is waged. Warfare is different today than it was a century ago, and is different than it will be a century from now. These past and future styles should not be viewed as better or worse, but should rather be seen as a reflection of the political interests and physical resources available at the time. Taking a page from Clausewitz and the comment about the chameleon nature of war, Julian Corbett wrote that, “war had not begun with the [Napoleonic] Revolutionary era, nor was it likely to end with it,” and he continued, “war would change again with other times and other

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[9] Delbrueck, *History of the Art of War*, 107.

[10] Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), Kindle edition, 594.

conditions."[11] The changes in warfare styles especially as it concerns weapons, therefore, are not the only important criteria in war, but still carry deadly significance for those in combat and for those whose fate is determined by such violence. In the effort to form a theory for air power, Giulio Douhet wrote, "In [a] period of rapid transition from one form to another, those who daringly take to the new road first will enjoy the incalculable advantages of the new means of war over the old."[12] The ability to recognize and adapt to disruptive change in warfare faster than the opponent bestows a significant relative advantage in combat. According to the U.S. Marine Corps, which again borrows heavily from Clausewitz, "While the basic nature of war is constant, the means and methods we use evolve continuously. Changes may be gradual in some cases and drastic in others. Drastic changes in war are the result of developments that dramatically upset the equilibrium of war such as the rifled bore, mass conscription, and the railroad [sic]."[13] This study, therefore, examines change in the character of war in these aspects of ideas and weapons. The decisions necessary to react to the change are captured in policy, strategy, and doctrine.[14]

2. Policy

Policy is the articulation of goals or objectives to achieve and maintain national interests, such as resources, power, and prestige. It is, as Hew Strachan writes, "a statement of one government's intent."[15] War can be used as a method to achieve national interests. Clausewitz wrote famously "war is merely the continuation of policy by other means," but he meant that statement in a theoretical sense and not a practical one for which he is routinely misunderstood.[16] War is not an extension of policy, but it can be

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[11] Corbett, *Principles of Maritime Strategy*, 23.

[12] Douhet, *The Command of the Air*, 30.

[13] U.S. Marine Corps, *MCDP-1*, 17.

[14] Christopher Mewett, "Understanding War's Enduring Nature Alongside its Changing Character," *War on the Rocks*, January 21, 2014, http://warontherocks.com/2014/01/understanding-wars-enduring-nature-alongside-its-changing-character/.

[15] Hew Strachan, *The Direction of War: Contemporary Strategy in Historical Perspective* (Cambridge: Cambridge University Press, 2013), Kindle Edition, 13.

[16] Clausewitz, *On War*, 87.

used to achieve policy. Strachan further clarified the popular quote by writing, "That is a statement about how governments might use war; it is not a statement about the nature of war."[17] If diplomatic power is insufficient to resolve a dispute between states, war is a choice to try to force the adversary into compliance through force. The latter portion, unconditional surrender by the enemy, for example, would be the policy. Or such policy could be more limited, in turn, depending on circumstances.

In a liberal democracy, the civilian and constitutional sovereign establish policy through a variety of institutions and mechanisms. The relationship however, between policy and civilian policymakers, and strategy and military commanders, is a duality fraught with problems that often have ended in failure or, in some cases, in success. Policy guides the formation of strategy, but strategy provides feedback to inform policy. In a postmortem of Operation Iraqi Freedom, U.S. Army Colonel Kevin Benson, who served as the lead planner for the ground force commander, offered the following advice to his peers about understanding policy: "While professional soldiers study war, in the 21st century they must also study policymaking. … Military professionals must understand the domestic and foreign pressures on the development of policy."[18] In this statement, Benson was merely repeating what a generation earlier had learned in Indochina, and others had learned in such conflicts as the Franco-Prussian war and those that followed.

In this study, policy options are an important factor influencing the application of autonomous warfare. Legal, moral, and ethical issues associated with such weapons are already widely debated when it coms to the development and use of lethal autonomous robots (LARs) or lethal autonomous weapons systems (LAWS). These examples relate to U.S. policy choices, but the enemy has a major role in changing the character of war too, as the current generation of U.S. service members have experienced in the era from September 11 until the present. If the people, government, and armed forces of the United

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17 Strachan, *Direction of War*, 12.

18 Kevin Benson, "A War Examined: Operation Iraqi Freedom, 2003: A Discussion With Kevin Benson, COL (USA Retired)," *Parameters* 43, Winter (2013): 122, http://www.strategicstudiesinstitute.army.mil/pubs/parameters/issues/Winter_2013/12_Benson.pdf.

States react slowly to the changing character of war in terms of making relevant policy, then its service members might be placed at a relative disadvantage in combat.

3. Strategy

Strategy concerns the relationship between force and policy. One of the most widely invoked definitions came from Basil Henry Liddell Hart who described strategy as, "The art of distributing military means to fulfill the ends of policy."[19] Bernard Brodie described it as "that border area where military problems and political ones meet."[20] Or for Hew Strachan, "strategy lies at the interface between operational capabilities and political objectives: it is the glue which binds each to the other and gives both sense."[21] The simplest concept of strategy, however, might be from Lawrence Freedman, as "the art of creating power."[22] The term *strategy* originated from the ancient Greek word *strategos*, referring to the title of a general and his subsequent actions.[23] Strategy, therefore, is inherently tied to the application of military power. "It is this element of force," wrote Michael Howard, "which distinguishes 'strategy' from the purposeful planning in other branches of human activity to which the term is often loosely applied."[24] Other endeavors, such as sports and business in the 20th century, for instance, have adopted the word strategy to refer to a general plan for success or simply a plan for the long-term. The application of force, however, is lost in these cases. For such other elements of national power as diplomatic or economic strategies, if the threat of force is an option then strategy may still apply.

In 1959, Bernard Brodie titled his book with the word *strategy* in relation to another era of new technology from thermonuclear weapons and rockets: *Strategy in the Missile Age*. Just over a decade had passed since the emergence of atomic weapons

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[19] B. H. Liddell Hart, *The Strategy of the Indirect Approach* (London: Faber and Faber, 1941), 187.

[20] Brodie, *Strategy in the Missile Age*, 7–8.

[21] Strachan, *Direction of War*, 12.

[22] Lawrence Freedman, *Strategy: A History* (Oxford: Oxford University Press, 2013), xii.

[23] Colin S. Gray, *Strategic Studies: A Critical Assessment* (Westport, CT: Greenwood, 1982), 4; Strachan, *Direction of War*, 28.

[24] Michael Howard, *Studies in War & Peace* (London: Temple Smith, 1959), 154.

changed the character of war. Advancements in aircraft and missile technology extended the range and firepower of thermonuclear weapons. The new military means, which represented such an extreme change in warfare, created perplexing problems for diplomats and military commanders. Brodie reflected on the state of strategic thinking at the time, examined the history of airpower theory, and then proposed his solution for a new strategy: deterrence.[25]

Regarding the state of contemporary strategic thinking in his era, Brodie composed this analogy:

> Nelson, whose flagship at Trafalgar was forty years old but equal in fighting capacity to the majority of the ships engaged, could spend his life learning and perfecting the art of the admiral without fearing that its foundations would shift under his feet. Today (1959) the basic conditions of war seem to change almost from month to month. It is therefore hard for the professional soldier to avoid being preoccupied with means rather than ends.[26]

The passage offers two relevant observations for this study. First, Brodie echoed the same sentiment as from Douhet and Clausewitz that the character of war does change. Second, and most important, was the implication that ends should trump means when thinking about strategy.

The task of this study is also to think of how changes in the character of war influences strategy. How does a new style of warfare affect decisions to wage war? Brodie's *Strategy in the Missile Age* offers a suggestive model to answer such a question. "For better or worse," Brodie wrote, "we shall be applying our intellects, as presently furnished, to new and baffling problems," and he continued, "In practical terms, therefore, we shall in the following pages attempt to scan the earlier development of strategic theory…and then consider some of the strategic policy choices confronting us today."[27]

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[25] Brodie, *Strategy in the Missile Age*, 271–72.

[26] Ibid., 16–17.

[27] Ibid., 20.

There has been an evolution in the meaning of strategy between its traditional and modern contexts. Certain forces initiated the change in the first half of the 20th century, but were ingrained as of the 1960s with the arrival of thinking about nuclear strategy. In his essay about the state of strategic thinking in 1968, Hedley Bull admitted, "strategic thinking at the present time is no longer exclusively concerned with the efficient conduct of war."[28] He went on to explain that attention has shifted from the use of war as an instrument to the threat of war to keep peace, along with several other changes in the state of strategic thinking–particularly the rise of civilian over military strategists. Despite any differences between traditional and modern definitions of strategy, however, so long as it retains the option of using military force, the nation still needs strategic thinking to be performed at an exquisite level.

In 2009, the University of North Carolina historian and former chief of U.S. Air Force history, Richard Kohn, proclaimed a decline of the U.S. military profession in its requisite ability to develop strategy. His article surveyed the making of strategy and the core of military professionalism since the Indochina war. He wrote, "In effect, in the most important area of professional expertise–the connecting of war to policy, of operations to achieving the objectives of the nation–the American military has been found wanting."[29] In 2013, the British historian Hew Strachan noted, "Today strategy is too often employed simply as a synonym for policy."[30] Later in the book he added the comment, which was copied from his 2005 essay on the present state of strategy, "The word strategy has acquired a universality which has robbed it of meaning, and left it only with banalities."[31] Colin Gray, in his inquiry of future warfare and the consequence of change in the technical character of warfare, asserted that, "All too often there is a black

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[28] Hedley Bull, "Strategic Studies and Its Critics," *World Politics* 20, no. 4 (July 1968): 593.

[29] Richard Kohn, "Tarnished Brass: Is the U.S. Military Profession in Decline?" *World Affairs* (Spring 2009): 74.

[30] Strachan, *Direction of War*, 10.

[31] Strachan, *Direction of War*, 27; Hew Strachan, "The Lost Meaning of Strategy," *Survival: Global Politics and Strategy* 47, no. 3 (Autumn 2005): 34.

hole where American strategy ought to reside."[32] If strategic thinking has in fact diminished, and if the timeline is hastening for the arrival of a new and complex style of warfare, then this study on the influences from the Robotic Age is warranted.

4. Doctrine and Concepts

Doctrine follows strategy. The term doctrine has been taken, especially in armies, from the Catholic church and applied to modern war, especially as the operational level of strategy has emerged since the middle of the 19th century. The making of doctrine also has become a subject of scholarly inquiry in strategic studies into nuclear and conventional operations since the middle of the 20th century. Doctrine provides approved guidance for the military's method of organization and conduct of war. Doctrine is authoritative, but it is not directive or binding in all cases because of the variety and innate differences in how conflicts unfold and armed forces fight. In other words, the terms and ideas contained in doctrine provide a common language to coordinate military effort (especially in large military and naval organizations) toward a shared objective, but it is not meant to constrain thought or flexibility.[33] Doctrine is merely a shared starting point for creative military commanders, particularly in a joint environment, to begin planning. Good doctrine should emphasize centralized planning, but then transitions to decentralized execution to adapt to the friction, uncertainty, and chance associated with war. Alfred Thayer Mahan's idea of sea power became doctrine in the late 19th century, not the least to give a purpose and shared institutional view to the new navy.[34] In more recent history, the U.S. Marine Corps manual *Warfighting* is an example of groundbreaking doctrine.[35] In a telling statement as the United States adopted the North Atlantic Treaty Doctrine of flexible response, General George Decker, U.S. Army Chief

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[32] Colin S. Gray, *Another Bloody Century: Future Warfare* (London: Orion Publishing Group, first published 2005, republished electronically 2011), Kindle edition, location 1715.

[33] *Joint Publication 1* defines joint doctrine as, "the fundamental principles that guide the employment of U.S. military forces in coordinated action toward a common objective," Department of Defense (DoD), *Joint Publication 1 (JP-1): Doctrine for the Armed Forces of the United States* (Washington, DC: Government Printing Office, March 2013), xxiv, http://www.dtic.mil/doctrine/new_pubs/jp1.pdf.

[34] Alfred Thayer Mahan, *The Influence of Sea Power Upon History, 1660–1783* (New York: Dover, 1987, first published by Little, Brown, and Company, Boston, 1890), 7–10.

[35] U.S. Marine Corps, *MCDP-1,* 1.

of Staff from 1960–1962, said, “Doctrine provides a military organization with a common philosophy, a common language, a common purpose, and a unity of effort.”[36]

An operating concept is a precursor to doctrine. The examples of German *blitzkrieg* and U.S. Marine Corps maneuver warfare began as concepts that later matured into doctrine. General James Mattis wrote that a concept is “an underlying idea for how [military] forces would operate in dealing with their respective challenges.”[37] Unlike doctrine, concepts are not authoritative. Instead, they provide the earliest basis for experimentation with new equipment and techniques, at times even before the materiel technology is readily available to the military. The value in developing concepts is to conceive of new ways for a military to fight and or operate in the future, which then drives the requirement to procure new capabilities and weapons. Like strategy, concepts are meant to solve problems in the future, but the only reference points to think about the real military challenges is what has existed in the past and present. In that regard, all concepts, though they may address the future, are also rooted in addressing challenges of service and operations that exist today. The more mature a concept becomes through testing, the more it will eventually be accepted as doctrine, especially if it survives the test of fire and assured success and victory. A goal for this study is to evaluate autonomous warfare as an operating concept that could eventually become doctrine.[38] This idea is similar to the goal adopted by the U.S. Navy’s Chief of Naval Operations Strategic Studies Group, which “generates revolutionary naval warfare concepts” and may plant the seeds for eventual naval doctrine.[39]

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[36] George Decker printed in DoD, *JP-1*, I-1.

[37] James Mattis, Commander U.S. Joint Forces Command, “Vision for Joint Concept Development,” Memorandum for U.S. Joint Forces Command (May 2009), 1, http://www.dtic.mil/futurejointwarfare/strategic/vision_concept%20development.pdf.

[38] Ibid., 2–6.

[39] Chief of Naval Operations Strategic Studies Group, U.S. Navy, last modified July 16, 2014, https://www.usnwc.edu/About/Chief-Naval-Operations-Strategic-Studies-Group.aspx.

5. Disruptive Military Innovation

In 2004, Terry Pierce pioneered "disruptive innovation theory" in relation to the character of war.[40] Pierce synthesized the four major pre-existing theories on military innovation into one concept that juxtaposed "disruptive" versus "sustaining" military innovations.[41] He claimed that a disruptive military innovation changes the character of war by introducing a new warfare style. A disruption is therefore a change in warfare, or a distinctly new way to conduct battle. A sustaining innovation, on the other hand, delivers incremental improvement to existing doctrine.[42] Sustaining innovations might introduce a major technological breakthrough with large performance gains and comparative advantage, but it is only when a new way of using the technology, which presents the enemy with a fundamentally different challenge, that the innovation is considered disruptive. In the words of Colin Gray, "the use made of technology typically is more important than is the technology itself."[43]

Pierce adopted his framework from Rebecca Henderson and Kim Clark, who developed a quad chart that categorizes innovations into either components or architectural linkage.[44] The *component* quadrants are divided into three levels: incremental (small scale), modular (medium scale), or radical (large scale). These components represent the new technology; for example, a machine gun, an airplane, or an aircraft carrier, respectively. Pierce used this model to show that the components alone only ever produce sustaining innovations. The *architectural* quadrant refers to the linkage of the components, or how the components are used together. A disruptive innovation occurs when a new concept proposes to employ the components in a novel way to create a new combat arm.[45] Generally speaking, disruptive military innovations are identified

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[40] Terry C. Pierce, *Warfighting and Disruptive Technologies: Disguising Innovation* (London: Frank Cass, 2004), 25.

[41] Ibid., 1.

[42] Ibid., 1.

[43] Gray, *Another Bloody Century*, loc. 1897.

[44] Pierce, *Warfighting*, 15–16.

[45] Ibid., 15–17, 25, 29.

with the word *warfare* in its title. Aircraft carriers, for example, are considered a radical component-level sustaining innovation, whereas carrier warfare is the disruptive innovation. Likewise, autonomous warfare, which will be the focus of chapter three, places emphasis on how autonomous systems will be used rather than on the technology itself.

Another way of thinking is that disruptive innovations do not arise from the technology alone, but rather from the concepts and doctrine that combine ways and means together. General James Mattis, known as a soldier scholar, once wrote that, "The right idea in the right situation can trump superior numbers and technology."[46] A primary theme for this study is to evaluate the possibility that autonomous warfare may become a disruptive innovation. The key is not just the new technology in the Robotic Age, but rather the unique ways technology will be used as thought and deed manifests itself in military organizations, or in those places with an impact on military organizations.

6. Robots and Robotics

The term *robot* is a loaded word. For many people it conjures a vision of fictional characters from movies like *The Terminator* so much so that it becomes difficult to maintain an unbiased view on the merits for or against using such an instrument in warfare. This study will therefore attempt to avoid the loaded term *robot* as much as possible, and rather focus on a more illustrative category of *robotics*. In this sense, robotics includes all things robot-like. As a baseline set of requirements, all robotic systems include at least four subsets: sensors, processors, effectors, and a power source.[47] Robotics, therefore, can range from independent autonomous systems, to dependent remotely piloted vehicles, to enabling technology that augments human performance, such as exoskeleton suits, and other complementary fields that make robotics function.

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[46] Mattis, "Vision," 1.

[47] Peter W. Singer, *Wired For War: The Robotics Revolution and Conflict in the Twenty-First Century* (New York: Penguin, 2009), 88.

By the time the Robotic Age is in full swing and robotic systems have become commonplace, "we probably will not even call them robots," predicts Bill Gates.[48]

7. Unmanned Systems

Unmanned systems are one example of robotics. Unmanned systems joined popular lexicon for military technology in the 21st century. The most notable form is the unmanned aerial vehicle (UAV), or drone, but unmanned systems can and do operate in all physical domains–space, air, land, at sea, and underwater. An unmanned system contains sensors, processors, effectors, and a power source, but the artificial intelligence is weak or non-existent. Unmanned systems can be stationary, but generally take the form of a self-transportable vehicle. These systems, by definition, do not contain a human operator on board. Unmanned systems generally divide into two categories: remotely piloted or autonomous. In this study, unmanned vehicles refer to dependent systems that rely on remote control, also known as remotely piloted vehicles (RPVs). Autonomous systems will be treated separately. Unmanned vehicles, therefore, are treated with the same legal prescription as manned systems because the human operator is responsible for all actions taken.

8. Autonomous Systems

Autonomous systems are another example of robotics. These systems also operate in all the physical domains, but to some degree mitigate the requirement for a human operator in the loop. All four subsets of a robotic system are present along with artificial intelligence that is strong enough to accomplish tasks independently. The simpler the task, the weaker the artificial intelligence can be. The ultimate goal for autonomous systems is to achieve a level of autonomy good enough to accomplish complex tasks, which would require strong artificial intelligence. Peter Singer characterizes the levels of autonomy as "direct human operation," "human-assisted," "human delegation," "human-supervised," "mixed-initiative," "fully autonomous," and "adaptive."[49] Depending on the

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48 Singer, *Wired for War*, 93.

49 Ibid., 74.

task, the distinction between unmanned and autonomous systems falls somewhere along this spectrum, especially in dealing with the use of force. Fully autonomous and adaptive, or learning, systems would make a robotic system not just an extension of a human operator, but a credible partner too. This thesis will evaluate the use of unmanned, autonomous, and robotic systems in a new form of warfare, but the meaning of the word *autonomy* will have implications for both man and machine.

9. Maneuver Warfare

The general style of maneuver warfare has been used by militaries since at least the battle of Cannae in the Punic Wars. Maneuver is about exploiting weaknesses while avoiding strengths through movement, maintaining a relatively faster tempo of operations, and physically out-maneuvering the enemy to turn his flank or encircle him. Claims to maneuver warfare are evident throughout history, as in Wallenstein's campaigns in the Thirty Years' War, in the campaigns of Frederick II in his wars, as well as in Napoleon's 1805 campaign.[50] Germany, following WWI, and the U.S. Marine Corps in the late 1980s also adopted maneuver warfare as their main doctrine. According to Williamson Murray, "the Germans invented modern war" in the latter half of WWI.[51] General Erich Ludendorff's decision in 1916–1917 to subordinate echelons of command and reform the waging of battle and combat resulted in the storm troop tactics, which returned the offensive to the battlefield, and furnished the basis to be joined with new fighting machines in the next generation with striking effect. Ludendorff's disruptive act had been to first break with hierarchy and custom in thought and practice based on the impasse on the western front, and second to see the possibilities for rationalistic change, which, although a failure in the spring 1918 offensive, bulked *blitzkrieg* in the German army for the generation that followed.[52] These developments formed an indicator that

[50] Donald Abenheim, email message to the author, April 22, 2014.

[51] Williamson Murray, "Armored Warfare: The British, French, and German Experiences," in *Military Innovation in the Interwar Period*, ed. Williamson Murray and Allan Millett (Cambridge: Cambridge University Press, 1996), Kindle edition, 28.

[52] Michael Geyer, "German Strategy in the Age of Machine Warfare, 1914–1945," in *Makers of Modern Strategy: From Machiavelli to the Nuclear Age*, ed. Peter Paret (Princeton, NJ: Princeton University Press, 1986), 541, 551–52, 572, 585.

Ludendorff could sense a pending change in the character of war, but it would be doctrine and strategy more than technology that would spell the importance of the change. The body of work for maneuver warfare created a basis for armored warfare to develop during the interwar period. This thesis will also use maneuver warfare to create a framework for autonomous warfare.

D. METHODS AND SOURCES

To organize the presentation of a possible place for robotics within the history of war and strategy, this study analyzes the historical case of armored warfare as a reference to learn about the impacts to doctrine, strategy, and policy when change in the character of war occurs. One might choose another set of examples, but the one used herein is persuasive because of the disruptive character of armored warfare. The context from that past example is then used, as did Clausewitz, Corbett, and Brodie to discuss a modern case of a changing warfare style and the advent of autonomous warfare in the 21st century. Underpinning the entire research project stands the study of classical history of military strategy and war. This discipline is the foundation of contemporary strategy, all claims of discontinuity notwithstanding. The sources include a variety of books, articles, research laboratory reports, and government documents.

This study assumes that the pace of technology will continue to evolve to make autonomous systems a reality. The paper is not questioning the technical feasibility for the use of robotics in war, but rather it is evaluating the implications at the operational and strategic level of war from technological advancements that appear not only inevitable, but also imminent. In the related field of oceanographic research using autonomous underwater vehicles, the visionary James McFarlane explained the future of his industry, which also happens to share the underwater space that is most likely to see the first uses of military autonomous systems:

> Ultimately, the use of autonomous vehicles and heterogeneous networks in the oceans on a large scale is inevitable. This is not only because of reduced cost and reduction in risk to personnel, but the introduction of

> vehicles is an integral part of the computer microprocessor robotic revolution, which is permeating every facet of human activity.[53]

Unlike years past when defense led industry, the speed of innovation today has the military following the private sector's lead.

E. OVERVIEW

This work unfolds in three parts. First, it reflects briefly on the current state of strategic thinking. Second, it generalizes about the doctrinal and strategic implications from armored warfare in the 20th century as a basis for comparison. Third, the thesis evaluates the operational and strategic consequences for a modern case of autonomous warfare as these issues appear in the year 2014.

The Robotic Age will add to the lineage of eras when technology shaped the conduct of war. Some of its predecessors included the Age of Firearms, the Age of Sail, the Machine Age, the Nuclear Age, the Missile Age, and more. During the Machine Age, the effort to gain an advantage for relative combat power placed humans inside machines of war. Today, militaries are witnessing a reversal of that concept, where the goal is to still keep the machines of war, but without the human inside. There are alternatives, however, where the advancements of robotics are being combined with the human warfighter as a hybrid system. Which is the right approach? The answer is important for militaries today because robotic technology is being developed in civilian universities, businesses, and laboratories worldwide; therefore, it will be subject to fast and easy proliferation. All of which hastens Douhet's warning to anticipate the changes in warfare.

The study does not contain or offer a rigid framework by which to analyze the past and current case studies. There are no hard and fast lessons learned to be gleaned from the past and reapplied to the future. The objective is to think about the process of change and imagine what unique solutions can be applied to new problems. Williamson Murray put it best in his study on the case of armored warfare, where his intent was to provide a "guide to what the past experiences of military organizations have been and

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[53] James McFarlane, "ROV's and AUV's: Tools for Exploring, Exploiting & Defending the Ocean Frontier," *UNDERWATER TECHNOLOGY 2000* (IEEE, May 2000), http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=852588&tag=1, 471.

how one might best think about innovation in the future."[54] Or, as Basil Henry Liddell Hart wrote in the opening of his book *The Strategy of the Indirect Approach*, "I was looking merely for light upon strategy."[55]

[54] Murray, "Armored Warfare," loc. 131.

[55] Liddell Hart, *Strategy of the Indirect Approach*, x.

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II. STRATEGY IN THE MACHINE AGE: ARMORED WARFARE

If the tanks succeed, then victory follows.

—Lieutenant General Heinz Guderian, 1937[56]

[I am] unwilling to give up a single horse or man from the horse cavalry in order to organize any mechanized units.

—Major General John K. Herr, 1938[57]

Mechanization makes war less mechanical.

—Sir B. H. Liddell-Hart, 1930[58]

A. THE MACHINE AGE

The Machine Age, as a consequence of the first industrial revolution, occurred between the middle of the 19th century and first half of the 20th century. During this period, the revolution of economy and society was most visible in the change of the telegraph and transport by steam, supplanted, then by the second industrial revolution with oil, electricity, and the internal combustion motor. The victory of machines in the industrial world with an emphasis on iron and then steel for carriage and combustible engines for power left no realm of human life unchanged with an acceleration and expansion of the range of human endeavor, for good and ill. This Machine Age and its impact on the face of war can perhaps be counterpoised to the so-called Digital Age, whose dawn came more or less in and, now, in the 21st century, with a Robotic Age. The Machine Age led to a union of fighting man and machine in new configurations, whereas the Robotic Age is leading to something else.

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56 Heinz Guderian, *Panzer Leader*, trans. Constantine Fitzgibbon (New York: Da Capo Press, 2002), 43.

57 David E. Johnson, *Fast Tanks and Heavy Bombers: Innovation in the U.S. Army, 1917–1945* (Ithaca, NY: Cornell University Press, 1998), Kindle edition, loc. 3096.

58 B. H. Liddell Hart, *Thoughts on War,* (London: Faber and Faber, 1944), 105.

The Machine Age initially altered the character of war with new artillery, railroads, telegraphs, smokeless powder, and the rise of general staffs. These changes accelerated with the advent of the machine gun, new kinds of warships, such as battleships and submarines, and aviation. The advent of these weapons from the 1840s to the 1930s combined in ways to change styles of warfare. The peak of military-related innovation during the Machine Age occurred between the 1920s and 1930s. In addition to items such as aircraft and aircraft carriers, which produced carrier warfare first tried by the British, Japanese, and then Americans, two other significant weapons emerged from World War One: armored fighting vehicles and radios. The fighting vehicles actually comprised an old idea that that was eventually realized following the second industrial revolution. Both items were important pieces of technology individually, but the real impact on fighting power was envisioning a new way the items could be employed together. This issue highlights the push and pull between inherent military conservatism and the impulse for technological and organizational change, that is, if tanks were used only to support Major General John Herr's horse cavalry, for example, then the potential for disruptive innovation would be lost. This fact, despite the equally compelling reality that the British invented the tank and first employed it in battle, and British military thought surpassed all others in a conception of how to use such weapons, only to be forgotten by the Allied militaries in the aftermath of WWI. Rather, the two items needed to be combined with a unique idea or method to create a new style of warfare that had not been demonstrated on the battlefield before, thereby imposing confusion on the enemy because such change in the character of war was not anticipated. The right combination of personalities, ideas, and technologies is what produced the disruptive military innovation known as armored warfare.[59]

B. ARMORED WARFARE

Armored warfare and its tactical air component, as waged by the German Wehrmacht, dominated the opening stages of World War II from the invasion of Poland to the fall of France. It represented a change in the character of war by emphasizing the

[59] Donald Abenheim, email message to the author, April 28, 2014.

factors of ideology, speed, armor, mobility, range, firepower, communications, and, to some degree, logistics. The new technology that embodied these factors included tanks, armored vehicles, radios, and railroads, but technology alone does not make for a disruptive innovation in warfare. In the French campaign, to be sure, the Germans were outnumbered in armored vehicles as well as aircraft, but were nonetheless able to defeat an opponent, who, a generation before, had resisted a German onslaught successfully. This chapter reviews the roles played by Great Britain, France, and Germany to spawn armored warfare, and compares the related impacts to policy, strategy, and doctrine in light of the new warfare style.

Of equal importance was connecting the tools to an operating concept that would employ the technology in new ways. Armored warfare, therefore, sprang from the Prussian-German legacy of war of maneuver, as well as the decision by the military and political leadership to experiment and implement the concept out of the desire to carry out an aggressive ideology of militarism and racial war, as well as due to some noteworthy innovations in military organization.[60] People and their ideas in a specific political context of the desire by the defeated Germany to avenge the defeat as well as the excellence of the officer corps, non-commissioned officer corps and fighting men, more so than technology itself, was the defining factor for armored warfare. This fact suggests that such a combination of people, machines, ideas, and institutions is central to the emergence of autonomous warfare.

The interwar period German army, despite it being hamstrung by the Treaty of Versailles and having not being the inventor of the tank, but rather its victims in the years 1916–1918, did the best to anticipate the change in the character of war that tanks could bring in the 1920s and the 1930s. Great Britain and France shared some responsibility for the development of armored warfare, but the Germans together with their Soviet silent allies in the 1920s were faster to mature the concept and consequently exploited the capability to their advantage.

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[60] Geyer, “German Strategy,” 528, 537–38, 541, 545, 559, 566.

1. Great Britain

With an already mature motor industry and high state of industrial development at hand in 1914, the British introduced the tank onto the battlefield in September 1916 during the Battle of the Somme. A modern analyst might observe that The Mark I tank was slow, unwieldy, and unreliable, but it was a revolution all the same in solving the problem of carrying fire power across the battlefield in search of tactical victory, even if the development of the tank progressed in fits and starts. The rise of the tank eventually demonstrated enough utility to warrant a field headquarters and be included in battle plans.[61] Unfortunately, as was the case with other materiel in 1914–1918, the British, French, and Americans could not manufacture tanks fast enough to produce a dominant impact on the battlefield until late in the war–but this moment was decisive all the same. When the tanks arrived, the Allies inflicted nearly one million German casualties in the summer of 1918 alone.[62] The traditional British regiments of infantry, cavalry, and artillery, however, were at the time perceived as the real basis of combined arms tactics. Tanks were perceived simply as a tool to support the existing main efforts of infantry, cavalry, and artillery, that is, as a mobile field gun, or machine gun. The British departed WWI with the wrong lesson in mind as concerns this subordinate role. The failure to embrace tactical and operational innovation, in part, as Strachan argues, because the lack of a general staff as a source of change, as well as the blind conservatism, made the British fail to heed such innovators as J.F.C. Fuller and B.H. Liddell Hart, the latter who well realized a change in the character of war had already begun. The British invented the tank, but they missed envisioning how this tool could lead to a disruptive military innovation and a new combat arm. It was in the role of an independent air force, a reaction to the strategic bombing of Britain that made for innovation in war in the air, but the ground remained the province of German progress.[63]

British policy and strategy following WWI mirrored the nation's revulsion of war and hope for collective security as well as the refusal to back a new continental

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[61] Johnson, *Fast Tanks*, loc. 704.

[62] Murray, "Armored Warfare," 13.

[63] Donald Abenheim, email message to the author, April 28, 2014.

commitment–the never again school with red collar patches and the collective memory of the Somme and such blood baths. For two decades following WWI, the British national sentiment was not only against war, but also maintained a derogatory opinion of the army, which was not without merit. This state of affairs did not help the military continue to innovate, particularly for equipment that offered little commercial value such as the tank. In 1937, Prime Minister Neville Chamberlain cut military spending to the point that all work to develop a modern tank stopped completely. Despite the promising capability of the tank and the role that the British had played in its inception, British policy ran counter to developing the fighting machine for a new kind of land war.[64]

British strategy in WWI emphasized positional, attrition warfare that hinged on the mass use of artillery. The main efforts were assigned to infantry and artillery, not tanks. Also in 1937, as the British way of war assigned strategic preeminence to the naval and air arms, Chamberlain "wholeheartedly embraced a strategy of 'limited liability,'" and said the purpose of the army was: "1) to protect the British Isles; 2) to guard the trade routes; 3) to garrison the empire; and 4) to cooperate in the defense of Britain's allies–but only after it had met its other commitments."[65] Not until late 1938 and early 1939, when diplomacy over Czechoslovakia collapsed, did Britain commit to rearm and develop a strategy to fight the Germans with a new continental commitment. By this time, the British were far behind the Axis in organizing, equipping, and training for the new style of warfare.

British doctrine to utilize tanks stagnated during the interwar period. The British not only ended WWI with an incomplete picture of the role of tanks in battle, but they turned their back on any rigorous study to advance operating concepts for more than a decade. Even when a report was released in the early 1930s to review the experiences of WWI, it was censored, and a version modified to maintain the institutional legacies was distributed to officers instead. British officers, such as B.H. Liddell Hart and J.F.C.

64 Murray, "Armored Warfare," 2–4.

65 Ibid., 4.

Fuller, also wrote about the promise of maneuver warfare, but they were perceived as radicals so the military did not absorb their ideas.[66]

All throughout the interwar period, the British Army made little progress in developing new doctrine for tanks. Only one senior military commander had the imagination and desire to experiment with the organization and warfare method of employing tanks in future battle. Field Marshal Lord George Milne tested new ideas and tried to make progress with the tank units, but only the Germans were listening and learning. In his study on the period, Williamson Murray noted that, "The British never established a coherent doctrine [for tanks] in 1918."[67] Lord Milne was an anomaly in the British army leadership. He saw a revolutionary future on the horizon for tanks, but the British army stuck with the traditional mindset of agreeable regimental soldiering. The stodginess continued into WWII as Field Marshall Alan Brooke made sure that none of the innovative tank commanders under Milne promoted to or above the division level.[68]

The British owned all of the technology necessary to develop the components of armored warfare. The regimental legacy, that is, the absence of a strong general staff, with an apathy for creative effort that hung over from WWI, however, prevented them from intellectually revolutionizing the concept of armored maneuver warfare. This condition stood in contrast to the Germans. In other words, the British had the components, but neither the intellectual nor institutional linkages to achieve a disruptive military innovation. The British failed to anticipate the change in the character of war due to civil military relations, politics, institutional, and personality shortcomings, which expressed themselves in society too. The public was war-weary, and rightfully so granted its huge sacrifice and the disappointments of the war and the peace. The military was equally prepared to maintain the traditions of regimental soldiering with its contempt for technology and its holdover ethos from the Indian Army and the fighting in Crimea in the middle of the 19th century. In reference to the tank, British policy was counterproductive,

66 Murray, "Armored Warfare," 13.

67 Ibid., 13.

68 Ibid., 21.

strategy was apprehensive, and doctrine was non-existent. Today, America is emerging from two wars and subsequently a war-weary public. The United States is a world leader in the development of robotics technology. For America to be successful in the Robotic Age, it must consider the relationships and effects from related policies, strategies, and doctrines so as not to repeat the British case with tanks. Of course, history reveals this kind of foresight as among the hardest tasks for commanders and diplomats alike.

The British example acts as a warning for nation states in the Robotic Age that lead the world in developing robotics, such as the United States. In Britain's case, the old overshadowed the new. If policies are set to limit testing and evaluation, and the signs are missed that robotics technology is leading to a change in the character of war, then another state could be first to unleash the disruptive innovation, or the unforeseen warfare style.

2. France

The French lost over 1.3 million men in WWI and although they dreaded a new war in Europe, the French did anticipate the looming threat from a rearmed Germany. The French prepared for the next war, unlike their British allies. The problem for the French was that they made those preparations based on national experience and culture that emphasized the defensive and the legacy of fortress building handed down from Vauban.[69] The French anticipated war would return to their border, but they did not correctly anticipate the kind of war that would storm west and the role of maneuver in the defensive.

French policy and strategy suffered from conflicts within civil-military relations in the vexed politics of the Third Republic. The government prohibited enough funding for research, development, and procurement of tanks as a revolutionary new tool for the army. Marshal Philippe Petain advocated a concept to establish layers of more or less fixed defenses within the nation's eastern border, but politicians resisted the idea that French industry be restricted within militarized zones. The compromise, as Williamson

[69] Donald Abenheim, email message to the author, April 28, 2014.

Murray described it, was a "thin, single line of powerful fortifications."[70] The Maginot line, despite its intent to provide overwhelming firepower, should be viewed as a sustaining innovation. It incrementally improved the French army's previous way of war of positional warfare, which was linear battle from static fortified emplacements.

French doctrine entering WWI advocated an offensive mindset, but heavy losses taught them not to expose their soldiers to German defenses. During the war, the French embraced tighter control, rather than adopting maneuver. After 1918 and throughout the interwar period, the French War College espoused the doctrine of "methodical battle."[71] This operating concept emphasized overwhelming firepower, but failed to recognize that the new German method would exploit static fighting positions through speed, surprise, and mobility. Even France's superior tank designs failed to make the leap to a disruptive innovation because they lacked the necessary linkage to a new operating concept or doctrine. The French actually had more tanks in its order of battle than Germany by 1940, but the French style of warfare did not exploit the tank's inherent traits of speed and maneuver. The concept of methodical battle not only imbued the French with a false sense of security, but it also prevented the French from comprehending the new operational method the Germans would employ.[72]

To their credit, the French tried to learn from the circumstances of WWI, and made a concerted effort to deter a German advance. The Maginot line was a good idea, but it turned out to be wrong. Unfortunately, the French fell victim to learning the incorrect lessons from World War I and failed to anticipate the potential for disruptive change in the character of war. "Lessons from the past are of value only if molded to the needs of the future," wrote RAND analyst Dr. Russ Glenn. He continued, "A military that does not balance looking backward with constant glances at the future risks preparing only for the last war fought," which is a sentiment that applies to both cases of France

[70] Murray, "Armored Warfare," 8.

[71] Murray, "Armored Warfare," 8, 26.

[72] Ibid., 26.

and Great Britain during the interwar period.[73] For states today entering the Robotic Age, the challenge is determining which aspects of past wars offer clues for the disruptive innovations lying ahead.

3. Germany

The British invented the tank in 1916 and the French possessed the most tanks by 1940, but the German army and air force envisioned the way that tanks could change the character of war. As historian Michael Geyer noted, "The main difference consisted in the way these means of industrial warfare were used."[74] While these facts are well known, it is difficult to explain why or why not new weapons become integrated in armories and arsenals, and how they change the character of battle and the face of war. Armored warfare resulted from the combination of mass politics, a military organization open to change, new technology, such as tanks and radios, with the principles of maneuver warfare and a revival of the offensive spirit in the German officer corps connected with the attitude of national socialism to soldiers and technology.[75]

Despite the defeat, the limitations of having no general staff, and no modern weapons, Germany embarked on secret arms efforts with the Soviet Union to break the Treaty of Versailles. This policy during 1921–1933 was complementary to the development of armored warfare for various reasons of politics, doctrine, and the imponderable of will borne of violence. The German army, in the desire to learn the reasons for the defeat at the tactical level, if not the strategic, as well as with the ideal of a small, elite cadre army secretly equipped with potential for modern weapons, did not suffer the same kind of self-imposed restraint as in Great Britain and France. The failure of the Allies to draw meaningful insights from combat as well as conflicted civil military relations contrasted with both the Germans and the Soviets. German General Hans von Seeckt wrote the doctrine of the Reichswehr in 1924 with an eye toward the advanced

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[73] Russell W. Glenn, "All Glory is Fleeting: Insights from the Second Lebanon War," *RAND National Defense Research Institute* (2012): xvi, http://www.rand.org/pubs/monographs/MG708-1.html.

[74] Geyer, "German Strategy," 542.

[75] Murray, "Armored Warfare," 30; Geyer, "German Strategy," 537–39, 541–45, 548–51, 559.

combination of air power and land warfare. He fitted existing ideas of maneuver warfare with the emergence of storm troop tactics, and represented an evolution of German tactics and operations reaching back to the Prussian Army in the 18th century.

Despite the strategic and materiel limitations imposed by the Treaty of Versailles, the government encouraged or looked the other way with secret arms efforts, and decided on rearmament with modern forces even before Adolf Hitler became chancellor in 1933. German elites decided to embark on a war footing. The Nazis corrupted the officer corps, and professional soldiers corrupted themselves with National Socialism and its violent and racist ideology. Hitler initially responded by assigning ambitious tasks and resources to the military. The intent of the German government was to build its dominant military power on the continent of Europe to undo 1918. When General Heinz Guderian (who borrowed from others) finally presented Hitler with his conception of armored war in the 1930s, Hitler provided the policy and funds necessary to build the panzer divisions for tank-to-tank battle. Of course, what Germany under Hitler did not have was a coherent military and economic strategy, and rational sense of ends and means. The German industrial base could not match the capabilities of the United States or the Soviet Union. Hitler's understanding of coalition strategy and maritime strategy were also too encumbered by a continental focus and upon the improvisation of campaigns, which accorded with his own psyche and temperament.[76]

German strategy hinged on winning at least one of two major campaigns out of a total of four being waged in WWII. These campaigns initially went well in their earlier stages, but collapsed in Russia. The Pacific played no major role once the German attempt to get the Soviets and the Japanese on the same side failed in late 1940. The North African campaign, the favorite of the Kriegsmarine, was never a contender in the continental focus of Hitler's thought and deed. Thus, the success in Western, Northern, Southeastern, and Eastern Europe was essential to German world power, and this plan did not succeed. Hew Strachan noted that strategy mostly came down to calculations of time

[76] Geyer, "German Strategy," 566, 571–73, 575, 578–87, 591–93.

and space.[77] With the latter being previously defined, it came down to a matter of time to secure one of the flanks, which would allow the full weight of German power to focus against only one threat instead of two. This problem existed long before the invention of the tank and long before Hitler gazed at the map of Europe in February of 1933 with the first official policy of conquest. German strategy thus was crippled from the start by a tendency to elevate tactics to strategy. Ludendorff had done this in March 1918, and his successors did it again with the operations in Austria, in the dismemberment of Czechoslovakia, with the Polish campaign, with the Scandinavian operation, and culminated in the initial success in Barbarossa, followed then by disaster.[78]

Not the least because of the violent ideology of German paramilitary and storm troop combat, German tactics relied on speed and maneuver to fight outnumbered and to win. The concept was revalidated in WWI, but failed due to the lack of armor and a sustainable supply train. From 1933 until 1938, certain German senior officers did not expect Hitler to engage in large-scale war until after 1940, allowing more time to build military resources for a war in the middle 1940s, and surely not a world war. They were wrong; however, the surprisingly swift acquisitions of the Saar, Rhineland, Austria, Czechoslovakia, Poland, Denmark, Norway, Holland, Belgium, and finally France, which were achieved through the inherent speed of blitzkrieg, presented a strategic and geopolitical opportunity: a foothold in the Western front.[79] Armored warfare as air land battle, however, such is the case with any single doctrine in war, does not make a whole strategy on the scale finally achieved by the Allies. Blitzkrieg could not fend off the onslaught of British and American maritime shipping, in which the Atlantic was revealed as the real battleground for the Western front, and in which the German navy was finally defeated by superior Allied forces and technology that defeated the U-boat, in spite of its near success in 1942. Concomitantly, the concepts of blitzkrieg were not going to be as advantageous with the enormity of the space and time considerations, not to mention less

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77 Strachan, *Direction of War*, 11.

78 Geyer, "German Strategy," 548, 550, 572, 575, 582–83, 586–87, 593.

79 Paul Kennedy, *Engineers of Victory: The Problem Solvers Who Turned the Tide in the Second World War* (New York: Random House, 2013), Kindle edition, loc. 514.

than full national effort, in facing the Eastern front. “Germany lost the Second World War in part for precisely that reason,” wrote Strachan, “that it made operational thought do duty for strategy, while tactical and operational successes were never given the shape which strategy could have bestowed.”[80] Armored warfare had proven to be a viable operational concept in certain circumstances, but still not a continental substitute for what had to be a global strategy.

German doctrine for armored warfare constituted a new, disruptive way of war that achieved early success. Murray claimed that, “The most important single factor in German innovation was the fact that they possessed a coherent doctrine based on a thorough and honest reading of the evidence.”[81] He described the framework for German doctrine to include six principles, which are a distillation of two centuries of Prussian-German and Habsburg experience in combat:

> German doctrine consequently emphasized conceptions that were starkly different from those of the British and French. The first was a belief in maneuver. The second emphasized an offensive mindset; the third demanded that commanders decentralize operations to the lowest level possible. The fourth required officers and NCOs to use their judgment on the battlefield; the fifth stressed that leadership at all levels must always display initiative. Moreover, all officers had to be thoroughly familiar with army doctrine and that doctrine was to form a coherent framework within which the whole army operated.[82]

The leading person responsible for converting the mindset of the German military from its WWI-era shortcomings was General Hans von Seeckt and his manual of combined arms written in 1924 as part of the reform of the defeated army.[83] He restructured the small officer corps to “one whose cultural ethos emphasized intellectual as well as tactical and operational excellence,” said Murray, and re-incorporated the time honored “general principles of initiative, exploitation, and maneuver” into German doctrine.[84]

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[80] Strachan, *Direction of War*, 40.

[81] Murray, “Armored Warfare,” 35.

[82] Ibid., 30.

[83] Ibid., 29.

[84] Ibid., 30.

Since the Germans had to use modern weapons either on the sand table, or in Russia, but not in Germany itself, their excellence with these phantom weapons grew while the French, British, and Americans misused aircraft and armor in the glow of peace.

Equipment from the Machine Age, such as tanks, radios, and railroads, filled the void then after 1933 from the WWI failings and gave the operating concept a lethal and sustainable punch. To this was added Nazi ideology, not the least of which was the results of the Hitler Youth, in which the aggressiveness already native to a generation was melded with new weapons and forces. Guderian eventually assembled these components into the panzer divisions and blitzkrieg, whereas the allies failed to do so, none more awfully than the Americans, but von Seeckt had already laid the foundation for the concept with his cadre army of 100,000 men with its highly selective training and education.[85] Although armored warfare could not alone win WWII, the concept would still influence military doctrines worldwide to this day and played a significant role in how the United States waged war in the Middle East in 1991 and 2003.

Perhaps the most intriguing aspect of Germany's initial efforts to develop armored warfare was the absence of having any tanks after 1919. The Treaty of Versailles prevented the German army from being equipped or training with tanks. The ideas for blitzkrieg, therefore, were partially fashioned from a close reading of reports from B.H. Liddell Hart and J.F.C. Fuller on British experimentation with armored units and maneuver warfare. This custom was merely a continuation of a lively, creative, and open debate in the ranks of a hierarchical organization about the realities of war and combat. The Germans learned from British field manuals to develop further and in detail already existing concepts of penetration and exploitation, and eventually from years of hands-on training in Russia together with the Soviets who embraced air land combat with equal fervor as did the Germans. This method of learning by proxy allowed the Germans not only to develop their own way of war, but also to sense how the enemy might attack.[86]

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[85] Murray, "Armored Warfare," 29–31; Donald Abenheim, email message to the author, April 28, 2014.

[86] Murray, "Armored Warfare," 33.

The German experience with armored warfare demonstrates how anticipating change in the character of war is a multifaceted challenge of policy, institutions, ideas, and, above all, the freedom among commissioned and non-commissioned officers to embrace something other than a generic textbook answer. Three things combined for the Germans to achieve a disruptive way of war: political will, institutional freedom, and excellence in not just the machinery, but also in the training, education, discipline, command, and morale in use of the technology. The technology was not on hand en masse, but it was feasible, and possible to obtain in sufficient numbers when rearmament took hold in 1933. The basis for the operating concept, maneuver warfare, was initially tested in WWI. And the culture formed from having the right personalities in place, which aligned with societal and institutional values at the time. The German army studied its recent history, and in this case anticipated correctly their aptitude to change the character of war.

C. CONCLUSIONS

This chapter opened with two opposing ideas about the future of warfare: linear versus non-linear battle. With the benefit of hindsight, one concept mistakenly held onto the past, and one boldly stated the future of warfare. How did strategists and national leaders anticipate change in the character of war, and what did they do about it? The three examples given were from states that developed radically different approaches to technological change. Ultimately, the disruptive innovation pursued by Germany required the alignment of three things: the right people with the right idea with the right equipment.

Several observations can be drawn from the development of armored warfare in the Machine Age. First, as the character of war changes, there is a right and wrong way to accommodate change, and the change requires more than just new technology. Second, a new, disruptive warfare style can be conceived and developed even before the technology matures and is broadly weaponized for battlefield use. The Germans faced heavy regulations under the Treaty of Versailles; they had no tanks, and still managed to

carefully study their tactical and operational performance in WWI to develop a potentially war winning concept. Third, stunning achievements in operational art may win campaigns, but there is no guarantee that it can replace sound grand strategy. Germany still lost WWII despite its early success from an advantage in doctrine. Blitzkrieg offered a chance to win decisive battles, but German strategy and policy extended too far. The technology in armored warfare was not a panacea, nor will that be the case for autonomous warfare.

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III. STRATEGY IN THE ROBOTIC AGE: AUTONOMOUS WARFARE

> *We are entering the era of robots at war.*
>
> —Peter Singer, 2009[87]

> *[The U.S. armed forces] cannot afford to defer the time, thinking, and investments needed to prepare for warfare in the Age of Robotics.*
>
> —Robert Work & Shawn Brimley, 2014[88]

> *Technology can enhance the ways and means of war by improving humanity's ability to wage it, but technology cannot and should not attempt to eliminate humanity from the process of waging war.*
>
> —U.S. Marine Corps, 1997[89]

A. THE ROBOTIC AGE

In 1898, Nikola Tesla demonstrated the first remotely piloted vehicle. The device was small and offered limited capability, but it was a precursor to the unmanned systems of today. What Tesla envisioned from his initial demonstration at the World's Fair was "an automobile carriage which, left to itself, would perform a great variety of operations involving something akin to judgment."[90] He also wrote:

> These automata, controlled within the range of vision of the operator, were…the first and rather crude steps in the evolution of the Art of Telautomatics as I had conceived it. The next logical improvement was its application to automatic mechanisms beyond the limits of vision and at great distance from the center of control.[91]

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87 Singer, *Wired for War*, 41.

88 Robert O. Work and Shawn Brimley, "20YY: Preparing for War in the Robotic Age," *Center for a New American Security* (January 2014): 36, http://www.cnas.org/20YY-Preparing-War-in-Robotic-Age#.U54TXBZgzjU.

89 U.S. Marine Corps, *MCDP-1*, 67.

90 Nikola Tesla, *My Inventions: The Autobiography of Nikola Tesla* (Williston, VT: Hart Bros., 1919; reprinted 1982), Kindle edition, 61.

91 Ibid., 60.

A century later, the right combination of technical ability and political will has finally achieved the necessary balance to make the Robotic Age an impending reality. In 2014, Robert Work and Shawn Brimley published a study titled, "20YY: Preparing for War in the Robotic Age."[92] The authors proposed that a "military-technical revolution" is underway, and that a new "warfare regime based on unmanned and autonomous systems has the potential to change our basic core concepts of defense strategy."[93] They postulate that successive generations of innovation in the field of robotics have led the technology to become a critical means for military planning. The advancements cited in their study include: "cyber warfare," "protected communications," "advanced computing and big data," "autonomy," "artificial intelligence," "commercial robotics," "miniaturization," "additive manufacturing." "small, high-density power generation systems," "electric weapons," and "human performance modification."[94] The phenomenon often used to describe the pace of change in these high-tech fields is known as Moore's law, which states that the number of transistors on a microchip doubled–thus making a faster chip–every 18 to 24 months.[95] "This convergence of exponential trends," wrote Peter Singer, "is why technologic change, especially for electronics, comes not only quicker, but in bundles, rather than staying within one category."[96] Other important categories in the robotics bundle include software reprogrammable devices to customize unmanned systems in the field, miniature satellites for global sensing and communications, and augmented reality for simulation training.[97] The latter is reminiscent of the German army developing armored warfare doctrine without possessing physical tanks for training. A challenge for the U.S. military is keeping abreast with the rapid pace of advancement. In

92 Work and Brimley, "20YY," 1.

93 Ibid., 6.

94 Ibid., 23–27.

95 Singer, *Wired for War*, 97–98.

96 Ibid., 99.

97 The Office of Naval Research is researching software reprogrammable devices, http://www.onr.navy.mil/en/Media-Center/Fact-Sheets/Software-Reprogrammable-Payload.aspx; the Naval Postgraduate School is researching CubeSats, http://www.nps.edu/About/News/Southcom-Turns-to-NPS-to-Evaluate-CubeSats-for-Communications-Support.html; and the University of California at San Diego California Institute for Communications and Information Technology is researching virtual reality simulations, http://www.calit2.net/research/academic_partners_culture.php.

the past, the Defense Department spurred innovation, with things such as stealth, global positioning, and satellites. Today, however, developments in the field of robotics are happening in the commercial sector, at universities located around the world. The U.S. military-industrial complex has more than one link to these sources, such as Defense Advanced Research Projects Agency and Naval Research Laboratory, but the U.S. government's notoriously cumbersome acquisitions process threatens to keep U.S. forces behind the technological acquisition curve. Potential adversaries, while they may not possess the same abundance of resources as the United States, are not as constrained in their processes, and the wide availability of new robotics technology could enable them to leapfrog ahead.

Work and Brimley contend that the current form of advanced warfare is based on a "guided munitions-battle network regime," and that the United States has eminent domain.[98] In other words, the U.S. military's ability to locate and target enemies with precision and limited collateral damage is the current zenith in warfare, as was demonstrated at its peak in the 1991 *Operation Desert Storm.* It was perceived that this warfare style changed the character of war so that mass of forces was traded for mass of effects. The authors suggest, however, that a new warfighting regime based on unmanned, autonomous, and robotic systems will introduce "a period of discontinuous change in both technology and warfare," which they also refer to as the "Age of Robotics."[99] The state or states that will emerge as experts of a new warfare regime is still unknown and resonates with the competition for armored warfare during the Interwar years.

In their paper, Work and Brimley identify four trends that will instigate a shift that poses a problem for the U.S. military to maintain its warfighting supremacy. First, the inevitable spread of technologies related to the guided munitions-battle network regime to other militaries and non-state actors will erode the U.S. comparative advantage. Second, a smaller U.S. military force structure may be inappropriate for the kinds of

98 Work and Brimley, "20YY," 8.

99 Ibid., 8, 28.

threats posed in the new warfighting regime, which will regain an emphasis for mass and quantity. Third, the bundles of advancements in robotics-related technology will stimulate a preference for unmanned and autonomous systems in battle. Fourth, with mass returning to the fore, and the cost of manpower getting too high, the result will be that mass is achieved through heavy use of unmanned, autonomous, and robotic systems.[100] Robotic Age technologies will be cost effective, commercially available, and therefore open to wider distribution than previous technologies designed specifically for the U.S. military. Other countries are pushing the technology to higher design limits, such as China's emphasis on "longer-range ballistic and cruise missiles," cites Work and Brimley.[101] The authors noted two additional trends that relate specifically to the nature of the U.S. military: the rising cost of both personnel and manned systems–air planes, ships, and ground vehicles.[102] Their conclusion is that there will be an inevitable rise of an unmanned, autonomous, and robotics warfare regime to compete against not only the international trends, but against the U.S. institutional trends as well.

With the technical feasibility only a matter of time, political, social, and economic interests are also driving towards the arrival of the Robotic Age. Work and Brimley noted that more than twelve million domestic robots were sold in 2012, and at least forty percent of states worldwide are pursuing unmanned systems.[103] Bill Gates, as one of the most credible sources on computer-related innovation, shared his thoughts on the possibility of a new era to emerge:

> As I look at the trends that are now starting to converge, I can envision a future in which robotic devices will become a nearly ubiquitous part of our day-to-day lives. … We may be on the verge of a new era, when the [personal computer] will get up off the desktop and allow us to see, hear, touch, and manipulate objects in places where we are not physically present.[104]

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[100] Work and Brimley, "20YY," 8–9.

[101] Ibid., 18–19.

[102] Ibid., 21.

[103] Ibid., 25, 7.

[104] Singer, *Wired for War*, 7.

In the National Defense Authorization Act of 2001, Congress legislated that one-third of deep strike aircraft be unmanned by 2010, and one-third of ground combat vehicles be unmanned by 2015.[105] At the time, virtually no robotic or unmanned systems were used to begin military operations in Afghanistan. By 2010, however, the military employed more than 15,000 unmanned systems in the air, on the ground, and in maritime environs across multiple conflict zones.[106] As of early 2014, General Robert Cone, director of the U.S. Army's Training and Doctrine Command, stated that the army is evaluating the possibility of replacing twenty-five percent of manpower in brigade combat teams with robotics and unmanned systems.[107] The U.S. military is still far from achieving the goals of legislation thirteen years ago, but new technology from the Robotic Age is clearly having an effect on militaries and societies alike.

Skepticism remains regarding the whole impact that robotics will have on society, but the volume of research, development, testing, and evaluation occurring worldwide for military robotics is undeniable. Governments, businesses, universities, and laboratories are advancing robotic systems for use in all the domains where conflict occurs–land, sea, air, and space. In many cases the technology is available commercially off-the-shelf and to the non-state actor for relatively low cost. The idea of prohibiting robotics from use in warfare is futile. Proliferation of the technology is widespread and offers an asymmetric cost advantage that cannot be ignored. In his assessment of future warfare, Colin Gray noted, "technological change has long been routinized and rendered transnational by the complex processes of diffusion."[108] This study does not suggest that robotics will change the enduring nature of war. Robotics and associated technologies will not replace humans, but rather empower human warfighters with a greater sense of autonomy. War

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105 *Fiscal Year 2001 National Defense Authorization Act*, Public Law 106–398 (October 2000): Sec. 220, 114 Stat. 1654A–38, http://www.gpo.gov/fdsys/pkg/PLAW-106publ398/pdf/PLAW-106publ398.pdf.

106 OUSD AT&L, "Unmanned Systems Integrated Roadmap, FY2011–2036," 22; Glennon J. Harrison, *Unmanned Aircraft Systems: Manufacturing Trends*, CRS Report R42938 (Washington, DC: Library of Congress, Research Service, January 30, 2013), 2.

107 Paul McLeary, "U.S. Army Studying Replacing Thousands of Grunts with Robots," *DefenseNews*, January 20, 2014, http://www.defensenews.com/article/20140120/DEFREG02/301200035/US-Army-Studying-Replacing-Thousands-Grunts-Robots.

108 Gray, *Another Bloody Century*, loc. 1564.

will remain fundamentally a political struggle for human interests, but robotics will alter the character of war by introducing new combatants on the field of battle, or by augmenting human soldiers so that new kinds of missions, which were deemed too risky or technically infeasible before, can now be accomplished. The advantage of new technology from the Robotic Age on warfare will be the yield of autonomy for human warfighters. If the U.S. military chooses not to employ its own robotic systems, it will nonetheless be fighting against adversaries with robotic systems in the future.

The Robotic Age will introduce an array of technologies that ranges from independent autonomous systems to ones that offer human-robot integration. The most apparent development will be the advent of autonomous systems that are capable of sensing, processing, and taking action independent from human control.[109] The remaining challenge to field these systems, however, is the lack of artificial intelligence strong enough to deal with a complex environment. Just when these systems will be mature enough for combat operations remains unknown. Other categories of technology in the Robotic Age, however, have already begun to change the character of war. Unmanned systems or drones, for example, which offer only limited artificial intelligence or are controlled by humans completely, comprise a type of new technology that is changing the way America performs counter-terrorism operations. Exoskeleton suits, which may augment a human warfighter with enhanced abilities to sense, process, and act, offer another example of how robot-like equipment will give autonomy to humans engaged in physical conflict. Aided by onboard sensors and processors, people will be able to concentrate more intellectual capacity towards the adversary rather than expending effort on the manual control of devices as required today. One of the side effects from advancing communications technology during the Information Age is that military commanders have developed a tendency to micromanage and strip discretionary authority away from subordinates. The U.S. military, in particular, has become dependent on maintaining its electronic communications for operational and tactical decision-making. In the Robotic Age, communications will be severely challenged through

109 Singer, *Wired for War*, 88.

electronic warfare, making it even more critical for individual warfighters to be trained and equipped in ways that empower autonomy on the battlefield.

Due to the arrival of new technology in the Robotic Age, and the asymmetric cost advantage gained by employing robotic systems, the enemy in the near future will present three difficult challenges to overcome. First, the enemy will be able to see vast amounts of the battle space in real time and with high resolution. Low power, high duty-cycle radar systems can now be used to monitor long coastlines with fine granularity and little cost.[110] Mesh networks of miniature satellites in space, along with ubiquitous Internet relays, will permit an adversary Google Earth-like coverage with real-time motion video. Second, the enemy will be able to conduct long-range precision strike. If the enemy can see everywhere, then the next worse outcome is his ability to strike everywhere. A missile, like a torpedo, is a type of robotic system. Like Tesla's early designs, cruise missiles were the precursors to today's unmanned systems. Several countries have designed missiles with a variety of range, precision, and explosive power that are sold among open markets, or underground.[111] Third, the enemy will rely heavily on deception, decoys, and diversions. In other words, potential targets will be presented not in ones or tens, but in hundreds or thousands. Combat elements will be small, and yet dispersed. The concept of swarm attacks is not new, but the availability of inexpensive, smart devices from the Robotic Age will make the idea a feasible and formidable challenge.[112] The new direction in warfare is heading towards light, fast, dispersed warfighters complemented by autonomous or unmanned machines. There will be more, small threats rather than less, large ones. The enemy will have better resolution to watch avenues of

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110 Matt Johnson, "Navico Unveils Revolutionary Broadband Radar Technology to Global Marine Industry at METS 2008," *Simrad*, November 20, 2008, http://pro.simrad-yachting.com/en-US/About-Us/News/Navico-Unveils-Revolutionary-Broadband-Radar-Technology-to-Global-Marine-Industry-at-METS-2008/.

111 For an introduction to Chinese and Iranian anti-ship missiles, see Robert Hewson, "That Sinking Feeling: Iran's Anti-Ship Missile Array," *Royal United Services Institute* (Summer 2012), 102–3, https://www.rusi.org/downloads/assets/RDS_201206_Hewson.pdf.

112 For an introduction to swarm tactics, see Sean Edwards, *Swarming on the Battlefield: Past, Present, and Future*, RAND (2000): xi, http://www.rand.org/pubs/monograph_reports/MR1100.html; or, John Arquilla and David Ronfeldt, *Swarming and the Future of Conflict*, RAND (2000): vii, http://www.rand.org/pubs/documented_briefings/DB311.html.

approach. The enemy will have a smaller signature, and will operate with a dispersed posture. The enemy will be faster and more difficult to target. The enemy will have an asymmetric cost advantage with commercial off-the-shelf technology and improvised weapons. The enemy will have greater range, endurance, and precision for strike and surveillance. Unless the United States develops similar capabilities or counter-capabilities it will be at a significant disadvantage. The combination of these challenges will add a new dimension to the character of war; therefore, a new form of warfare is necessary for the U.S. military to maintain its dominance.

Tesla predicted that his vision of "Telautomata will be ultimately produced, capable of acting as if possest (sic) of their own intelligence, and their advent will create a revolution."[113] After entering the Robotic Age, Tesla's vision is no longer a prediction, but rather a reality. The introduction of intelligent robotics acting in harmony with people on a battlefield is enough of a departure from previous warfare styles that it will constitute a new way of fighting–a disruptive military innovation. To reconcile the challenge of integrating humans and robotics together in war, and to reemphasize the function of autonomy in warfare, a new operating concept is required.

In light of the challenges posed by a new warfighting regime in the Robotic Age, Work and Brimley implore the U.S. military to design new operational concepts and evaluate the strategic implications. In the *20YY* paper, the authors write:

> To allow the U.S. military both to weather these buffeting winds of change and to capitalize on real opportunities to extend America's technological edge, DOD must urgently spur new thinking and research on the changing [character] of warfare and the types of new systems, organizations, and operational concepts needed to conduct it.[114]

A new operational concept designed around the unmanned, autonomous, and robotics regime is needed; a concept that emphasizes the human element in robotic warfare.

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[113] Tesla, *My Inventions*, loc.1033.

[114] Work and Brimley, "20YY," 9. The word *nature* was changed to *character* to maintain context within this thesis. The change does not conflict with the intent of the two authors as they also refer to the consistent *nature*, yet changing *character* of warfare.

B. AUTONOMOUS WARFARE

Autonomous warfare is an operational concept that exploits the advantages of unmanned, autonomous, and robotic systems to increase autonomy and freedom for the human warfighter, thereby producing a comparatively faster tempo for tactical and operational decision-making. Robotic–and robotics-related–systems will enable the warfighter with sensors, processors, and effectors beyond the normal range of human limits to unburden the most effective weapon in warfare: the human mind. This warfighting concept is necessary for the United States to maintain a competitive edge in light of growing manpower and manned equipment costs, and the trends of other states adopting the disruptive technology presented in the Robotic Age.

Autonomous warfare is a warfighting philosophy to deal with how the character of war will change during the Robotic Age. It is a way of thinking about warfare that highlights the importance and resurgence of autonomy for human warfighters. The word *autonomy* can be misleading in a modern sense because of its frequent and popular use in association with developing robotics. When one hears the words *autonomy* or *autonomous,* the thought is often connected to unmanned systems that are able to operate independently, but the words should not be so constrained. Throughout military history autonomy has always been an important factor; therefore, it should not be related only to robotics. Autonomy is a feature that most importantly affects humans in their warfighting and decision-making capabilities. Navy commanders at sea in the age of sail, for example, coveted their autonomy. In 2012, Chairman of the Joint Chiefs of Staff General Martin Dempsey released a white paper titled, "Mission Command," in which he called on the Joint Force to institutionalize "decisive initiative" among subordinates.[115] New technology in the Robotic Age is merely a reminder of how crucial the factor of autonomy has always been in warfare. In this concept of autonomous warfare, autonomy applies to both man and machine. Both will be given increased independence, authority, and decision-making ability. Autonomous systems are a means to achieve the goal of

115 Martin Dempsey, "Mission Command," white paper, April 3, 2012, 6, http://www.dtic.mil/doctrine/concepts/white_papers.htm.

preserving autonomy for people to deal with the array of fast and dispersed threats presented in the Robotic Age.

Work and Brimley labeled the "successor to the guided munitions-battle network regime as the '20YY regime.'"[116] The name was derived from the 1995 Office of Net Assessment series of war games called "Future War 20XX."[117] The names were chosen to imply the inevitability of the shift and to curtail arguments over exact dates. The term *regime* is useful to describe the collection of capabilities that arise from a military-technical revolution, but this paper attempts to go a step further and characterize a warfare style that the U.S. military can use to man, train, equip, organize, and employ its forces. It also does not propose tactics, techniques, or procedures for autonomous warfare, but rather aims to provide an operational view of the philosophy and evaluate the strategic implications for the new warfighting regime.

1. Operational Concept

Autonomous warfare combines the warfare philosophy of maneuver warfare with new technologies from the Robotic Age, such as unmanned systems and exoskeleton suits, to present a new warfighting style. In a similar vein, armored warfare was an expression of maneuver warfare combined with tanks and radio communications. In autonomous warfare, however, more emphasis is needed for discretionary authority–autonomy–to deal with a faster and more dispersed enemy threat.

One of the earliest conceptions of maneuver warfare came from General von Seeckt in his resurrection of the German army following World War I. As noted in Chapter II, von Seeckt's framework to rebuild the German officer corps in the 1920s laid the foundation for Guderian and other German generals to unleash armored warfare in the 1930s and 1940s. Von Seeckt rewrote German doctrine based on six tenets: maneuver, an offensive mindset, decentralization, judgment, initiative, and professional study.[118] The U.S. Marine Corps adopted these concepts, and more, in its foundational text *Marine*

116 Work and Brimley, "20YY," 30.

117 Ibid., 16.

118 Murray, "Armored Warfare," 31.

Corps Doctrinal Publication 1: Warfighting (MCDP-1), first written in 1989 and updated in 1997.[119] Now entering the Robotic Age, maneuver warfare and MCDP-1 still offer relevant advice for the construction of autonomous warfare. MCDP-1 best describes maneuver warfare as "a warfighting philosophy that seeks to shatter the enemy's cohesion through a variety of rapid, focused, and unexpected actions which create a turbulent and rapidly deteriorating situation with which the enemy cannot cope."[120] Maneuver warfare encompasses such factors as speed, surprise, deception, flexibility, independent thought, initiative, courage, self-discipline, loyalty, decentralization, and human elements of command that emphasize trust and decision-making.[121] All of these factors play a role in autonomous warfare, not only in how autonomous and robotic systems might incorporate the traits, but also in how the human warfighter is imbued with the above characteristics. What follows next are the six factors most important for defining the character of autonomous warfare: speed, dispersion, autonomy, deception, human-robot integration, and risk tolerance.

First, speed has traditionally been measured in physical terms. Especially in relation to operational maneuver, speed may be thought of as the connector between time and space; how fast can a unit outflank the enemy. In the Robotic Age, speed will retain its importance and connection to the physical domains as unmanned systems can achieve performance levels beyond the limiting factors imposed on manned vehicles (i.e., oxygen requirements, G-force limitations, and armor specifications). The processing power of future computer systems will also be exponentially faster than today. And yet the defining factor of speed for autonomous warfare will not be in physical terms, but rather in a mental capacity: the speed of decision-making. Warfare, despite all the new technology, will remain fundamentally a human endeavor to pursue human interests. All of the robotic systems, therefore, aim to enable human warfighters to make decisions faster than the adversary. In MCDP-1, "whoever can make and implement decisions

119 U.S. Marine Corps, *MCDP-1*, 1.

120 Ibid., 73.

121 Ibid., 74–86.

consistently faster gains a tremendous, often decisive advantage."[122] One of the most widely acclaimed methods of combining the aspects of speed into physical and mental terms was John Boyd's model to observe, orient, decide, and act (the "OODA loop").[123] Boyd's style of thinking emphasized "ambiguity, deception, and mobility" to generate surprise for a decisive edge.[124] Autonomous warfare is an attempt to seize the opportunity, and as Boyd wrote, "He who is willing and able to take the initiative to exploit variety, rapidity, and harmony–as a basis to create as well as adapt to the more indistinct–more irregular–quicker changes of rhythm and pattern, yet shape focus and direction of effort–survives and dominates."[125] The OODA loop will continue to be an important tool in autonomous warfare because the robotic systems will carry the load in observation, orientation, and action while leaving the people to focus on decision.

Second, mass has long been considered one the fundamental principles of war, dating back at least to Antoine-Henri de Jomini's nineteenth century *The Principles of War*.[126] Work and Brimley, however, claimed that the guided munitions-battle network regime in the past few decades challenged the idea of mass as an effective principle for both offensive and defensive reasons. Rather than operating in large units to mass forces, the operational concept shifted to mass effects.[127] In light of the new technology emerging in the Robotic Age, the principle of mass will again become an important factor in military planning, but in a new way. The factor of dispersion, or dispersed elements of mass, is important to autonomous warfare. Small teams of humans will work with large groups of unmanned, autonomous, or robotic systems that cover wide areas. The threat of ubiquitous sensing and precision munitions will keep the human combat elements small, but the electronic counterparts will operate in vast networks of hundreds or thousands. It is not to say that one unmanned system cannot operate individually, as will be seen with

122 U.S. Marine Corps, *MCDP-1*, 85.

123 John Boyd, "Patterns of Conflict," in *A Discourse on Winning and Losing* (lecture, 1987), slide 72.

124 Ibid., slide 48.

125 Ibid., slide 174.

126 Baron de Antoine-Henri Jomini, *The Art of War*, trans. G.H. Mendell and W.P. Craighill (Radford, VA: Wilder, 2008; reprinted from West Point, NY: U.S. Military Academy, 1862), 52.

127 Work and Brimley, "20YY," 12.

the exoskeleton suit, but rather that the full benefit of autonomous warfare will be achieved by leveraging mass and mobility from the robotic systems. Dispersed mass is different from traditional ideas of mass because groups or swarms of robotic systems will relocate quickly throughout the battle space to prevent from becoming static targets, like the battalions of old. It is the combination of mass and speed that facilitates the idea of dispersion, or dispersed mass.

Third, autonomy may seem like an obvious factor in autonomous warfare, but it may not be for the obvious reasons. The technology that is related to robotic systems operating autonomously or semi-autonomously is not the focal point in autonomous warfare. Similarly, the word *maneuver* contains much greater meaning for maneuver warfare than just the ability to physically relocate. Unmanned, autonomous, and robotic systems from the Robotic Age will give people engaged in combat a greater sense of autonomy, independence of thought, and freedom for action. In MCDP-1, "It is this freedom for initiative that permits the high tempo of operations that we desire. Uninhibited by excessive restrictions from above, subordinates can adapt their actions to the changing situation."[128] In reference to maneuver warfare, this concept of autonomy or initiative is constrained to the human relationships between commander and subordinate. In autonomous warfare, however, unmanned, autonomous, or robotic systems are like a new echelon of command, albeit always the lowest level. Never would a human become subordinate, but the robotic system could have other systems under its command. That arrangement would leverage the most capability with the least burden on a person commanding a network of unmanned or autonomous systems. Issuing maneuver warfare style mission tactics to a robotic system would achieve more autonomy for the human commander to place effort and focus elsewhere. Another benefit of robotic systems is that trust, obedience, loyalty, and discipline are afforded to the person in command immediately.

Fourth, deception is a key component for autonomous warfare to achieve maximum success. Also integral to maneuver warfare, deception and surprise are traits

128 U.S. Marine Corps, *MCDP-1*, 87.

perfectly suited for unmanned, autonomous, and robotic systems. With robotic systems operating in large yet dispersed networks or swarms, human operators can feign presence in more than one place by electronic spoofing or unmanned decoys. In a future battlefield where the enemy can see all the combatants through an abundance of satellite coverage and low-cost radar networks, the way to gain an advantage will be disguising which elements are manned versus unmanned. The added cost for the enemy to distinguish between threats purchases more time and space for the human warfighters to pursue the commander's intent.

Fifth, human-robot integration, while not imbedded in maneuver warfare, is a bedrock component of autonomous warfare. During the Machine Age, weapons and systems were characterized as crew-served. Or, as Daniel Pick described the impact of Marxism on society and warfare, "the machine has become the subject."[129] In other words, the people served the weapon to make it function. In autonomous warfare, the order is reversed and the system serves the person. Autonomous wingmen, for example, that fly in formation with a manned aircraft extending his or her defenses and weapons range without requiring manual control to be flown, or assuming additional risk. Or, an exoskeleton suit that augments human performance seamlessly, adding strength, endurance, and situational awareness, without detracting from the operator's ability to think independently. Although autonomous warfare flips the notion of crew-served on its head, the human-robot relationship is more than just a one-way interaction. In the *20YY* paper, Work and Brimley recognized that in autonomous warfare humans and robotics have a symbiotic relationship: "In such a regime, the 'winners' will likely be those who best leverage the unique advantages of both machine and human intelligences."[130] The authors invoked the term "'free play' chess" from Tyler Cowen's book *Average is Over* in which human-machine teams displayed the best performance in playing chess. Work and Brimley conclude, "In a future warfighting regime dominated by guided munitions and unmanned and autonomous systems, those who master 'free play' combat by

129 Daniel Pick, *War Machine: The Rationalisation of Slaughter in the Modern Age* (New Haven, CT: Yale University Press, 1993), 53.

130 Work and Brimley, "20YY," 30.

harnessing the relative cognitive advantages of both humans and machines will likely dominate the battlefield."[131]

Sixth, autonomous warfare will be an even more progressive form of maneuver warfare because the unmanned and autonomous systems allow for a greater degree of risk tolerance. According to MCDP-1, "The essence of the problem is to select a promising course of action with an acceptable degree of risk and to do it more quickly than our foe."[132] With robotic systems serving as the "recon screen," as William Lind described the forward elements that test an enemy's defenses for apparent weakness, the commander can be more risk tolerant.[133] Due to the characteristics of speed and mass incorporated into autonomous warfare, the robotic recon screen can exploit the gaps faster than before. In cases where the human-robot integration is one for one, such as with an exoskeleton suit, commanders will still be able to tolerate a greater degree of risk because of the added resilience and protection afforded to the person inside. New missions that would not be considered before will become acceptable with autonomous warfare.

Two different examples of how autonomous warfare might take shape are offered here. First, an example using dispersed mass and deception, and second, a case emphasizing human-robot integration and risk mitigation.

a. Antifragile UAV Network with Asymmetric Strike

The reader might envision a scenario to find and neutralize mobile long-range cruise missile launchers that are well hidden, and if discovered forcefully defended. In addition, it would be safe to assume such an environment employed a mature guided munitions-battle network regime to create the kind of anti-access and area denial strategy that is vexing to the U.S. military. Autonomous warfare would propose to flood the contested air space with what Work and Brimley termed a "reconnaissance-strike

131 Work and Brimley, "20YY," 30.

132 U.S. Marine Corps, *MCDP-1*, 86.

133 William S. Lind, *Maneuver Warfare Handbook* (Boulder, CO: Westview Press, 1985), 19.

swarm."[134] The authors believed that "networked, cooperative swarms of unmanned systems that can maneuver and engage targets collectively" could act faster than humans.[135] The UAVs might take the shape of a small craft with an onboard fuel cell, or a larger platform equipped with thousands of pounds of fuel to extend range and loiter time, or a combination of both.[136] In either case, the cost of the systems would be relatively low, so hundreds or thousands can be employed creating a massive network of robotic recon screen elements. The UAVs would be equipped with sensors to find the missile sites outright, but it should not always be expected to work due to the enemy defenses. The key assumption is that the enemy would react to defend the areas where it is most sensitive. In other words, the UAV network would monitor enemy activity on the ground, or begin to take fire from short-range surface-to-air defenses, which in itself is a signal. The cooperative network of UAVs would adopt a quality of being "antifragile," to quote the term from Nassim Taleb.[137] An antifragile UAV network would respond to the point of attack either in force for a direct response, or in terms of situational awareness by simply informing the commander of the situation in case a more indirect response is preferred. In other words, the UAV network, being antifragile, would autonomously and immediately identify the points where the enemy wants to defend the most: the missile sites.

In addition to the ability to locate, the UAVs would also be lightly armed, for example, with the lightweight and inexpensive Spike missile.[138] Autonomous warfare is intended to provide the U.S. military with an asymmetric cost advantage in weapons and platforms. In other words, the UAV with a lightweight, low-cost strike capability could

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134 Work and Brimley, "20YY," 29.

135 Ibid., 29.

136 The Naval Research Laboratory is developing fuel cell technology for unmanned aircraft, http://www.nrl.navy.mil/lasr/content/ion-tiger-fuel-cell-powered-uav; the Defense Advanced Research Projects Agency is developing parafoil unmanned aircraft that could be modified to carry thousands of pounds of fuel instead of cargo, http://www.darpa.mil/NewsEvents/Releases/2012/06/26.aspx.

137 Nassim Nicholas Taleb, *Antifragile: Things That Gain from Disorder* (New York: Random House, 2012), Kindle edition, 3.

138 Meghann Meyers, "Navy Develops 'World's Smallest Guided Missile,'" *NavyTimes*, February 23, 2014, http://www.navytimes.com/article/20140223/NEWS04/302230006/Navy-develops-world-s-smallest-guided-missile-.

offer an asymmetric cost advantage to damage a more sophisticated target, similar to the way improvised explosive devices were used to good effect against U.S. forces in Iraq and Afghanistan. A swarm of UAVs would be able to combine their effective striking power. The enemy missile site would not have to be destroyed, just disabled, and prevented from achieving its delicate and precise mode of operation.

Another function for a cooperative UAV network under the rubric of autonomous warfare would be to act as decoys or diversions. The antifragile UAV network could be assigned mission-type orders to create confusion for the enemy in one area, allowing the opportunity for a main effort of human operators to conduct an operation elsewhere with less resistance.

This concept requires a volume of UAVs that would have been considered abnormal in the past. Numbers will range in the hundreds or thousands, depending on the scope of the problem, but that will become the character of autonomous warfare. Thousands of UAVs flying overhead with long range, long endurance, low cost strike weapons, and antifragile cooperative properties that poses a difficult targeting solution for the enemy and creates the potential for significant confusion in his decision cycles.

b. Tactical Assault Light Operator Suit

The Tactical Assault Light Operator Suit (TALOS) is a U.S. Special Operations Command (USSOCOM) project to accomplish two things: first, build an exoskeleton suit that enables special operations forces with capabilities to perform new missions, and second, reinvigorate the defense acquisitions process. According to USSOCOM, the TALOS vision statement is to "Develop a peerless war fighting system with impervious protection, superhuman performance, surgical lethality, and exponential awareness."[139] TALOS is an example of a robotic complement to the human warfighter that will make autonomous warfare possible to achieve.

USSOCOM provides the national command authority with military options that offer the highest levels of precision and discretion to achieve strategic effects. In the

[139] U.S. Special Operations Command, "TALOS Way Ahead Directives" (Tampa, FL: USSOCOM, January 6, 2014), 5.

future operating environment of the Robotic Age, the challenge of enemy capabilities to see everywhere and strike everywhere will continue to prompt the use of what the Secretary of Defense called "innovative…and small-footprint approaches."[140] Autonomous warfare will not remove human commanders from the battlefield, which is why TALOS is so important. In terms of its human-robot integration, TALOS will improve a person's capabilities with protection, sustainment, awareness, and lethality. As USSOCOM describes, "The ability to independently operate in all environments in small numbers and unexpected ways with the capacity to exercise extreme discretion…will be strategically decisive against near peer competitors and networks hiding behind failed states."[141] Missions with strategic importance that could not be attempted or completed before, such as *Operation Eagle Claw*, the failed hostage rescue operation in Iran, may become feasible in wholly new ways because of the TALOS project. TALOS is a perfect example of the free play intended from human-robot integration, increased speed in decision-making, and coordination among dispersed elements of cooperative reconnaissance-strike swarms.

Some observers may argue that an exoskeleton suit worn by a human does not comprise an autonomous system, and therefore would not be part of autonomous warfare. Even USSOCOM stated that "Autonomous capacity is the lowest risk option, but is decades away in terms of the sophistication required for these mission sets."[142] Both arguments, however, miss the essence of autonomous warfare. That is, autonomy is a feature in warfare that is waged by human warfighters regardless if the measure of autonomy is afforded to a ship captain sailing the first warship, a special operator wearing an exoskeleton suit, or a fighter pilot with autonomous wingmen. Humans will always be required in combat for their decision-making abilities to pursue the human interests of war. TALOS is a phased approach to autonomous warfare where fewer humans will be involved, yet enabled by more unmanned, autonomous, and robotic

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[140] Secretary of Defense, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense* (a.k.a., *Defense Strategic Guidance*) (Washington, DC: Department of Defense, 2012), 3.

[141] USSOCOM, "TALOS Way Ahead," 5.

[142] Ibid., 5.

systems than ever before. The increased capabilities will buy down the tactical risk for politically sensitive missions, therefore, reducing the commensurate strategic risk and allowing commanders to take action.

The second objective for the TALOS project is equally important for the U.S. military to retain a competitive edge in the Robotic Age. USSOCOM describes the effort as "A pilot program to pioneer a new, faster, more agile acquisition process."[143] Defense columnist Stew Magnuson reported that USSOCOM "is teaming with 56 corporations, 16 government agencies, 13 universities, and 10 national laboratories" on the TALOS project.[144] Although it has generated some consternation among Congress, USSOCOM's effort on TALOS is exemplary of the kind of creative thinking and new technology required for autonomous warfare to be effective in the Robotic Age.

2. Strategic Implications

Autonomous warfare is a way to address strategic problems that will confront the United States in the Robotic Age. To recall from Chapter I, strategy is the relationship between the use of force and the ends of policy. For the purpose of this paper, it is safe to assume that future U.S. policy interests will remain similar to today–that of maintaining U.S. leadership in the world economically, militarily, and politically. The broad question, then, is about how the use of force through autonomous warfare achieves that end.

Autonomous warfare has the capacity to change the way nations conceive war in many respects. States may change calculations of risk or the financial cost of war. Populations may change their perceptions of fairness and humanity, or question legal, ethical, and moral standings about lethal robotic systems. Foreign policy options may be altered because new military options become available, or previous styles no longer make sense. In his analysis of the impact of robotic systems on sea power, Bruce Berkowitz posed two questions that are equally relevant for autonomous warfare: "What military

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143 USSOCOM, "TALOS Way Ahead," 1.

144 Stew Magnuson, "Special Operations Command Wants X-Prize to Develop 'Iron Man' Suit," *National Defense*, February, 11, 2014, http://www.nationaldefensemagazine.org/blog/Lists/Posts/Post.aspx?List=7c996cd7-cbb4-4018-baf8-8825eada7aa2&ID=1405&RootFolder=%2Fblog%2FLists%2FPosts.

requirements can [unmanned systems] address, and how do these requirements fit into U.S. strategy? … And, finally, what are the legal, policy, and diplomatic issues?"[145]

Autonomous warfare has strategic consequence in terms of the comparative advantage between states. For decades, the United States has been dominant in the use of military force due to the guided munitions-battle network regime that the U.S. military-industrial complex created. In the Robotic Age, however, Work and Brimley suggest, "advances in the commercial sector will likely trigger the military-technical revolution associated with unmanned, robotic, and autonomous attack systems."[146] With modern globalization connecting the private sector to universities and non-state actors worldwide, the source of this trigger cannot be guaranteed American. If other states are more aggressive to adapt their styles of warfare to account for the new technology, then those states could be first to establish a comparative advantage in their favor. Autonomous warfare, therefore, is a way of thinking for the U.S. military to remain positively engaged with and in pursuit of not only the disruptive technology, but also the way it will be used. The philosophy will leverage new Robotic Age technology in the most effective warfighting manner, which is to emphasize the autonomy and decision-making capability of people in war. Should the United States decide not to adopt the new warfare style, for example, because of fear or protest against lethal autonomous systems, it will then be confronted with the challenge of fighting against autonomous warfare at the hands of an adversary. "In the usually long interludes between wars," penned Brodie, "it is both easier and pleasanter to dwell on what we shall do to the enemy on D-day than on what he will seek to do to us. Our plans are much more easily developed and pushed to a properly offensive conclusion if we can imagine the enemy as inert or at least passive."[147] America is not entering the Robotic Age alone. The United States may or may not lead the world in innovation during the Robotic Age, but surely potential revisionist states will be in pursuit of disruptive technologies for an asymmetric

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[145] Bruce Berkowitz, "Sea Power in the Robotic Age," *Issues in Science and Technology*, February, 5, 2014, http://issues.org/30-2/bruce-2/.

[146] Work and Brimley, "20YY," 31.

[147] Brodie, *Strategy in the Missile Age*, 43.

advantage. The loss of a comparative advantage in the use of force would erode U.S. power, and reduce American credibility to maintain its place as the leader of the international system.

Diplomatic relations with other states is closely related to and affected by the previous discussion of comparative advantage. Japan and South Korea, for example, are global leaders in the commercial development of unmanned, autonomous, and robotics technology.[148] Both states also participate closely in defense agreements with the United States. If these Asian states perceive enough of a comparative advantage in the field of defense-related robotics over an indifferent United States, and a potential competitor state in China or North Korea exhibits a proclivity for autonomous warfare, then long-standing defense treaties in the Asia region could be diminished. Diplomatic ties could also be hampered in another way if the United States is effective in developing autonomous warfare, but is hesitant to share its advancements with allies for fear of again losing its comparative advantage in another warfare regime.

One of the obvious implications for adopting autonomous warfare is the connection to force structure. The United States is facing years of military downsizing from budgetary cutbacks. The cost of manpower and manned equipment is on track to overwhelm the U.S. military budget. As written above, proponents from Congress to the U.S. Army have proposed that significant portions of the U.S. military arsenal begin to utilize unmanned, autonomous, and robotic systems to offset the cost of manpower and manned systems. The philosophy of autonomous warfare allows this shift to occur, but maintains faith in the idea that the core strength of the U.S. military remains its people. Although there may be fewer men and women in service, the level of discretionary authority and trust afforded to them should increase.

Finally, new technology from the Robotic Age may redefine U.S. defense strategies. Within the realm of conventional deterrence, the loss of a comparative advantage due to the wide availability of unmanned, autonomous, and robotic systems may pit the unlikeliest of states as a peer competitor to the United States–or so it may be

148 Work and Brimley, "20YY," 33.

perceived. In such a case, it will not be the equipment, but rather the methodology that makes a difference. Similar to the comparison of when Great Britain, France, and Germany all possessed tanks, yet only one capitalized on early success from armored warfare. In the future, autonomous warfare will be the method or way to exploit human-robot integration. According to Work and Brimley, "speed, mass, deception, and geography could play more central roles than in the recent past."[149] The first three factors are fundamental aspects of autonomous warfare, and the last is synonymous with military strategy.

An examination of strategy in relation to unmanned systems and autonomous warfare is important because strategy should be the guide for the employment of forces and their weapons. Cutting-edge technology always precedes a mature strategy, but as soon as possible the strategist needs to assert control and elevate ends above means. In the approach to the Robotic Age, operational concepts and strategy are lagging behind the technology. The United States Government has established policy guidance for the development autonomous and semi-autonomous systems for lethal and non-lethal use that is lenient enough, and calls for the addition of doctrine as well.[150] The Defense Department updates a comprehensive 25-year roadmap for unmanned systems annually, but the document features mostly tactical, technological, and financial issues.[151] Moore's law has observed the exponential growth of computing power during the latter half of the 20th century, and the trend is expected to continue for at least another decade. In an interview with Peter Singer, the futurist Ray Kurzweil remarked that humanity is poised to experience "about twenty thousand years of progress in the twenty-first century, one thousand times more than we did in the twentieth century."[152] In other words, neither technological impotence nor political indifference still poses the obstacle that it did for

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149 Work and Brimley, "20YY," 31.

150 Deputy Secretary of Defense, "Department of Defense Directive 3000.09: Autonomy in Weapon Systems" (Washington, DC: Department of Defense, November 21, 2012), 2–3, http://www.dtic.mil/whs/directives/corres/pdf/300009p.pdf.

151 OUSD AT&L, "Unmanned Systems Integrated Roadmap, FY2013–2038" (Washington, DC: Government Printing Office, 2013), 1, http://www.defense.gov/pubs/DOD-USRM-2013.pdf.

152 Ray Kurzweil, interviewed December 7, 2006 and published in Singer, *Wired for War*, 102.

Nikola Tesla when he first demonstrated the Art of Telautomatics in 1898. In addition to defining the operational concept for autonomous warfare, it is equally important to resolve the strategic implications of what new technology from the Robotic Age will entail for the U.S. military. Strachan wrote, "Strategy is a profoundly pragmatic business: it is about doing things, about applying means to ends. It is an attempt to make concrete a set of objectives through the application of military force to a particular case."[153] In Chapter II, it was possible to have a complete discussion of strategy because the means, or style of engagement, and purpose of war were known. In the Robotic Age, the means available are quickly becoming identified. The challenge moving forward with autonomous warfare will be to identify and understand the purpose of a war, and connecting the means to achieve the ends.

153 Strachan, *Direction of War*, 12.

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IV. CONCLUSION

It is easy, of course, to overemphasize the influence of machinery in war. It is man that makes war, not machines, and the human element must always remain the dominant one.

—General Douglas MacArthur, 1934[154]

No degree of technological development or scientific calculation will diminish the human dimension in war. Any doctrine which attempts to reduce warfare to rations of forces, weapons, and equipment neglects the impact of the human will on the conduct of war and is therefore inherently flawed.

—U.S. Marine Corps, 1997[155]

Strategic history tells us that people matter more than machines.

—Colin S. Gray, 2005[156]

This paper has two objectives. The first is to reflect on the threats, opportunities, and effects upon strategic thinking that will arise as the Robotic Age changes the character of war. The second is to introduce the operational concept of autonomous warfare, which should spur new doctrine, policy, and strategy, as a way for America to retain its global military and political strength. Autonomous warfare stresses a balance between the enduring aspects of the nature of war–the human element–with the anticipated changes in the character or war–robotics technology. The comparison was made between autonomous warfare and a previous example of disruptive military innovation, that of armored warfare leading up to and during WWII. The two examples are similar in the amount of interaction between man and machine in wartime, but each proposed a different philosophy about the man supporting the machine, or vice versa. Chapter II opened with an epigraph from B.H. Liddell Hart, which began,

154 Douglas MacArthur in Johnson, *Fast Tanks*, loc. 2556.

155 U.S. Marine Corps, *MCDP-1*, 14.

156 Gray, *Another Bloody Century*, loc. 1515.

"Mechanization makes war less mechanical," but he continued, "Superficially this may seem a paradox. But the effect is natural. For by reviving mobility and fluidity it breaks the shackles of trench-warfare."[157] By extension, robotization makes war less robotized. This phrase might also appear a paradox, but the philosophy behind autonomous warfare is meant to furnish the American way of war with a renewed sense of autonomy not only for machines, but also, and more importantly, for the people who fight. Autonomous warfare will break the shackles of the battle network regime, which through the Information Age, presented technology that allowed commanders to micromanage operations from afar, and burdened operators with too much crew-served equipment. Now, the technology exists to set the user free.

The title for this paper, "Strategy in the Robotic Age," was chosen to align with Bernard Brodie's classic work, *Strategy in the Missile Age.* His book provided a frame of reference to think about how changes in the character of warfare influences strategic thought. He analyzed the combination of air power and thermonuclear weapons, which arguably caused the largest impact upon strategic thought in the 20th century. Yet, it is another theme that connects the Missile Age to the Robotic Age: strategy was lost in the former, and should be rediscovered in the latter. The traditional sense of the word strategy has its roots in the classical era from the late eighteenth to the early twentieth centuries. Soldiers and scholars such as Clausewitz, Jomini, and Paul Gideon Joly de Maizeroy all shared in writing and creating the traditional concept of strategy, and particularly military strategy. When Germany lost WWI, however, due to economic and political difficulty rather than military effects, the idea of strategy began to change. In 1911, Julian Corbett introduced the juxtaposition that strategy is divided into "minor strategy" and "major strategy," with the former retaining its traditional connection to military strategy and the latter covering what would eventually be thought of as "national strategy" or "grand strategy."[158] The notion of a major or grand strategy opened the door for strategy to extend beyond the realm of generals, and that wars could be decided by

[157] Liddell Hart, *Thoughts on War*, 105.

[158] Strachan, *Direction of War*, 15.

more than just military means. WWI was also the beginning of airpower, and the precursor to the beginning of the Missile Age.

After WWI, J.F.C. Fuller extended the concept by comparing wartime versus peacetime strategy, but argued that strategy should not be divided and a state should maintain a unified view of strategy. As a result of blending the ideas of wartime and peacetime strategy together, it meant that strategy no longer retained an inherent connection to the use of force, as Sir Michael Howard had contended. Strategy, then, could be about the potential use of force, or the threat of force, which was arguably more in line with non-violence than violence. The Cold War cemented this concept, and for decades American institutions lost touch with the original meaning of strategy.[159] "Strategy was now to be applied in peacetime," wrote Strachan, and strategy started to be seen as "the application of national policy."[160] He added, "After 1945, therefore, strategy and policy had become conflated in people's minds."[161]

After the advent of nuclear weapons and intercontinental delivery systems, the Missile Age was in full effect. The meaning of strategy during the Missile Age grew more diffuse. Clausewitz defined strategy as "the use of the engagement for the purpose of the war."[162] Following the realization that nuclear war was an existential threat, however, strategy shifted from the use of force to win war to the threat of force to prevent war. The realm for devising strategy shifted from the military to academia, which attempted to rationalize and calculate methods for nuclear deterrence. The practice of strategy had, therefore, been taken away from generals and admirals as their sacred art of practice.[163]

Following the political and military struggles in Vietnam, the U.S. military responded by devising a new level of war to regain its professional mastery: the operational level of war. Operational Art became the strategy of old; traditional military

159 Strachan, *Direction of War*, 16.

160 Ibid., 16.

161 Ibid., 16.

162 Clausewitz, *On War*, 177.

163 Strachan, *Direction of War*, 17.

strategy of devising how military means can be used to win the war. And that is roughly the state of strategy today. Civilians make policy, generals practice operational art, and the dialectic trade space for ideas to make strategy is often left unattended. All of these developments, from the initial displacement of strategy to claims of it being a lost art, or from the beginnings of air power to the guided munitions-battle network regime, took place during the Missile Age. Strategy was lost in the Missile Age.

The Robotic Age presents a critical opportunity for the U.S. military to regain its strength for strategic thought. Not only because the practice of strategy needs to be resumed in the 21st century in general, but also because the types of new challenges that will come during the Robotic Age demand a coherent strategy for the United States to remain dominant. The magnitude of WWII and the Cold War understandably shifted the view from classical military strategy to grandiose national strategy. The kind of conflicts, however, that also requires thought and expertise on the level of traditional military strategy has not abated. Wars in Vietnam, Afghanistan, and Iraq are only the most obvious examples in a much longer list. Autonomous warfare is a philosophy and methodology that is inherently about giving independent thought and discretionary authority back to the warfighter.

Of course this process will not be done easily. Strachan observed that strategy is composed of analyses between time and space.[164] Neither of which can be known very well into the future. History has shown, especially in the case of armored warfare, that predicting the next kind of war, and which technology is most appropriate, is exceedingly difficult. Aside from the tools of combat, the geography or geopolitics of a future conflict are also unpredictable. Invoking Clausewitz again, "strategy is the use of the engagement for the purpose of the war."[165] Autonomous warfare describes the style of engagement, or how force can be applied, but the purpose of the war, or the specific objectives to be achieved in war, remains unknown. "Wars are defined by the hostility which underpins them," wrote Strachan who added, "the participants need to know who the enemy is, not

[164] Strachan, *Direction of War*, 11.

[165] Clausewitz, *On War*, 177.

least in order to be able to construct a strategy with which to direct the war."[166] Exactly who is the enemy against which the U.S. military might apply autonomous warfare is not clear, but that does not alleviate the need to prepare an operational concept that can eventually become part of a coherent doctrine and strategy.

If the Robotic Age and autonomous warfare stand for anything, it is, perhaps ironically, to canonize that human intellect is the essential element in warfare. Technology will never replace all people in war, but successive generations of robotics technology will continue to supplant human involvement in some of the mundane, dangerous, and computation heavy tasks. According to the U.S. Marine Corps, "The art of war requires the intuitive ability to grasp the essence of a unique military situation and the creative ability to devise a practical solution."[167] People will always be needed to develop the war winning strategies. This thesis, therefore, is about the beginning of an effort to renew strategy in the Robotic Age. Exactly how autonomous warfare will help to achieve this goal is unknowable until more tangible factors about a place, an enemy, and objectives in war are revealed, but the concept is a good way to view the balance of robotics, humanity, and autonomy in warfare.

As of 2014, still in the early stages of the Robotic Age, the U.S. military's position with unmanned, autonomous, and robotic systems resembles the early days of British innovation with tanks. Both states invented the technology and were among the first to employ it in battle. The way the U.S. military has incorporated robotic systems thus far, however, could be characterized as an evolutionary approach, or in Pierce's terms, a sustaining innovation. The important question to ask is if that is the right approach. It could be right, or it could be wrong; it is too early to tell. The military could do well to follow Pierce's advice to innovate among many small and disconnected groups to spur independent thought, and to pay close attention to other states that appear to be using robotic systems in thoughtful, disruptive ways. For the true test of unmanned systems will be in battle. In his collection of *Thoughts on War,* B. H. Liddell Hart

166 Strachan, *Direction of War,* 12.

167 U.S. Marine Corps, *MCDP-1,* 18.

lamented, “The money spent on armies that failed to adapt themselves to changing conditions has proved too literally a sinking fund–acting as a millstone round the investor’s neck when he was plunged into the deep waters of war.”[168] Will the United States be first to develop a disruptive military warfare method from robotics, or will someone else, as did the Germans, be able to envision the way to change the character of war?

168 Liddell Hart, *Thoughts on War*, 105.

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